SCIENCE

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APPLIED CHEMISTRY[1]

IT is only three years ago that a Brooklyn alderman, who, in the absence of the mayor of New York, had to welcome the visitors to the International Congress of Chemistry, addressed them as if they were druggists or pharmacists.

After all, he made not a much greater mistake than many so-called educated men who obtained a B.A. and yet are ignorant enough of elementary scientific knowledge to imagine that the main occupation of a chemist is to analyze substances and detect falsifications.

Even in England, a pharmacist is currently designated as "chemist," while a real chemist is called an "analytical chemist."

But the European war has done much to correct some of these mistaken notions of the public at large. Our daily press has now more or less acquainted this country with the fact that in our national make-up there is such a thing as chemical problems. I doubt, however, whether the unthinking masses have begun to realize that aside of the so-called chemical industry, practically every other industry, in fact, every enterprise, has chemical questions to contend with, and that chemical industry itself is intimately interwoven with the great network of every modern industrial or agricultural state; that the economic welfare of our country and the health of its citizens are largely dependent on the way we utilize our chemical knowledge.

The present war has been aptly called a "chemical war," because efficient work of

[1] An address presented at the meeting of the American Chemical Society, Seattle, Wash.

every department of the fighting armies, from the Red Cross service to the manufacture of guns and explosives, involves incessantly chemical knowledge and—still more chemical knowledge.

But do not imagine that this is the first chemical war: The art of killing and robbing each other became "chemical" the day gunpowder was invented; at that time, however, the existing knowledge of chemistry was just of pinhead size. Napoleon knew very well how to use adroitly exact knowledge and chemistry for furthering his insatiable ambition to dominate the world; so he surrounded himself with the most able chemical advisers and scientists, and, for a while at least, he placed himself at a decided advantage over his many enemies; incidentally, he thus helped to lay the foundation for some very important branches of chemical industry.

"Les chiens ont appris quelquechose," exclaimed the Corsican conqueror when he realized that his enemies began to adopt the same means which had given him temporary mastership over them; but those whom he called so contemptuously "the dogs" finally beat him at his own game.

Ever since then, science, technology and chemistry in particular have played a rôle of increasing importance in the armament of nations. This accounts perhaps for the strange fact that the really great military inventions have practically all emanated from civilians and from non-military nations like our own. If the men of the military class, essentially conservative in all countries, had been left to their own devices, they would probably still be fighting with bows and arrows, or perhaps with the traditional sling. Nor should the pacifist blame the chemist if the latter's most beautiful conquests in science, if his proudest discoveries, have been turned into means of relentless destruction and human slaughter. Do not reproach chemistry with the fact that nitrocellulose, of which the first application was to heal wounds and to advance the art of photography, was stolen away from these ultra-pacific purposes for making smokeless powder and for loading torpedoes. Do not curse the chemist when phenol, which revolutionized surgery, turned from a blessing to humanity into a fearful explosive, after it had been discovered that nitration changes it into picric acid.

As well might you curse written speech or language or the art of printing—by which the most noble thoughts of the human race have been expressed, disseminated and preserved—if it has been used also to distribute the vilest lies and the most damnable errors.

Knowledge is like a knife. In the hands of a well-balanced adult it is an instrument for good of inestimable value; but in the hands of a child, an idiot, a criminal, a drunkard or an insane man, it may cause havoc, misery, suffering and crime.

Science and religion have this in common, that their noble aims, their power for good, have often, with wrong men, deteriorated into a boomerang to the human race. Our very successes will threaten to devour us as long as all of us have not yet become imbued with the truth that greater knowledge, like greater possession of wealth or power, demands a greater feeling of responsibility, greater virtues, higher aims, better men.

Let us hope, in the meantime, that war carried to its modern logical gruesomeness, shorn of all its false glamor, deceptive picturesqueness and rhetorical bombast, exposed in all the nakedness of its nasty horrors, may hurry along the day when we shall be compelled to accept means for avoiding its repetition.

Would you take it amiss if I made a digression from my subject as an answer to repeated attacks which have been made of late by some shortsighted men who blame our increasing scientific knowledge in general and our chemical science in particular, for the excesses of the present European war?

But let us turn our attention to more peaceful chemical pursuits and more particularly to the chemists of this country.

Their work is difficult to understand and still more difficult to be appreciated by the uneducated or uninitiated; nor do chemists court the plaudits of an ignorant public that can not understand them; they feel fully compensated by the results of their work if it only meets with the approval of a few of their fellow chemists, irrespective whether it brings them financial results or not; in fact, most chemists are so much in love with their work that very often they neglect the financial side, to their own immediate detriment.

Unlike the physician, lawyer, clergyman, actor, writer, artist or business man, the chemist does not depend on the public at large; he is either engaged in some private enterprise or he acts in a consulting capacity for a few people, or he is teaching in some educational institution. Popularity in the usual sense has little or no value for the chemist.

No wonder then that the chemists of this country, numerous and active as they are, have hardly been noticed among the daily noise of newspaper sensation and shrieking publicity—no more than a skillful watchmaker would be noticed among the hammering of a busy steam-boiler-manufacturing plant.

And yet, right here in the United States, the chemical profession has taken such a root, such a development during the later years, that our national American Chemical Society, which counts over 7,000 members, has by far the largest membership of any chemical society in the world, with all due respect to England, France and Germany; a society which finds it possible to spend yearly over $100,000 on its three chemical publications, copies of which are to be found all over the world in every well-equipped scientific library. Nor is the study of chemistry in this country a matter of recent occurrence. Our European friends are astonished when we tell them that as far back as 1792, there existed already the Chemical Society of Philadelphia, which was probably the first chemical society ever organized in the world; some of the papers presented at the meetings of that early scientific body furnish even today very interesting reading. Some of our American educational institutions equipped chemical laboratories for students at a time when exceedingly few of the best-known universities possessed any such facilities. In fact, the Rensselaer Polytechnic Institute of Troy, New York, established a chemical laboratory at about the same time as was founded the famous laboratory of Liebig, at the University of Giessen, 1825, and the movement for the establishment of laboratories in the United States was independent of that in Europe.

Nor should we overlook the fact that notwithstanding the essentially pragmatic tendencies of our country, the United States has given to the world a Willard Gibbs, who out-theorized existing chemical theories and whose mathematical deductions are still, after his death, furnishing food for profound thought to the most renowned physical chemists of Europe to whom they have opened entirely new fields in the study of chemical dynamics.

I mention this more particularly for the reason that our aniline-dye-consumers have taken the chemists of the United States

bitterly to task and have made decidedly unfavorable comments upon their abilities, because, since the European war, dyes could no longer be imported from Europe. But Dr. B. C. Hesse, an American-born chemist, a graduate of the University of Michigan, has already ably answered this indictment of the American chemists. In a paper full of information on this subject, which he presented at the New Orleans meeting of the American Chemical Society,[2] but which, unfortunately, has received little or no attention from our daily press, he has clearly demonstrated that the aniline-dye-consumers of the United States can have all the chemists and all the dyes they want; provided they are willing to make the necessary investments of capital and to submit to the risk of uncertain profits by starting their own dye-manufacturing establishments here in the United States instead of, as in the past, favoring imported dyes, either through personal prejudice, or by fostering legislation which forbids the home manufacturers to utilize such methods of selling agreements as "Kartels" or other consolidations of interests; or "dumping," so as to kill new competitors in the field, while making up the temporary loss by increasing the price of other products, and, in general, any of the many other trade-arrangements and trading tricks freely and openly utilized by European manufacturers so as to stifle possible competition of our home aniline-dye-producers.

The outcry which has been raised as to our shortage of artificial dyes is out of all proportion if we take in consideration that the annual importation of dyes and synthetic products from Germany amounts only to about $9,000,000. Mr. A. D. Little, a former president of the American Chemical Society, pointed out[3] that this represents about the same money value as the amount of candy sold annually by the Woolworth ten-cent stores.

The development of any chemical industry is a matter of local opportunities; for instance, the manufacture of cellulose, as well as the industry of wood-distilling, has taken a greater development in the wood-covered sections of the United States than in Germany or any other country in the world.

The magnitude and earning capacity of the largest German chemical enterprises, however imposing they may be, look less important if you take into consideration that some of these companies have been in existence for more than half a century. Much younger American chemical enterprises, which make American specialties—for instance, the Eastman Kodak Company, which sends its films and photographic papers throughout the world—have annual earnings decidedly greater than the most successful German chemical works of much older existence. Nor is the value of the output of some of our largest purely chemical companies much less important than that of the German concerns.

This country is now the greatest producer of sulphuric acid, with an annual production of about 3,000,000 tons. Yet it is not so long ago that the first maker of sulphuric acid had trouble to find purchasers for a triflingly small production of a few tons per week. It needed the opportunity of a home market; by and by this market was created through the refining processes of petroleum after the discovery of our oil fields; the discovery of natural phosphates and the resultant industry of superphosphates; the use of dynamite for blasting; the development of the glucose

[2] See *Journal of Industrial and Engineering Chemistry*, Vol. 7, No. 4, April, 1915, p. 293.

[3] See *Journal of Industrial and Engineering Chemistry*, Vol. 7, No. 3, March, 1915, p. 237.

industry, electrolytic copper refining, etc. These and many newer industries all required large amounts of sulphuric acid and gave this country an opportunity of developing sulphuric-acid manufacturing to its present magnitude. In fact, the same reasoning holds good for all of our industries. I doubt very much whether the talented foreigners, who have now become famous in chemical manufacturing, would have tied their initiative and enterprise by specializing in coal-tar-dyes manufacturing, if they had had the limitless opportunities of an immense undeveloped country like ours, to which to give other outlets to their spirit of pioneership, mining, transportation, agriculture and similar subjects, all beckoning for more urgent attention, and offering at the same time more immediate rewards.

In the meantime some of our other chemical industries, better suited to our local conditions, have taken such an enormous development here as to make the United States an undisputed leader in at least some of them. Such products as the various acids and salts, aluminum, artificial abrasives, calcium-carbide, soda and caustic alkalies, bleaching powder, chlorine products, electrolytic copper, are decidedly more imposing in value and in economic importance than the few million imported coal-tar-dyes.

Mr. F. A. Lidbury, of Niagara Falls,[4] pointed out rightly that if there had been a shortage in some of the products of our electrochemical industries in which the United States has been a pioneer, the consequences to our national economics would have been so serious that the present complaint of our aniline-dye-users would have sounded like a timid whisper, compared with the bellowing lamentations of so many more important industries which would have become absolutely paralyzed. The fact is that few men realize how many industries are directly dependent on the work of American chemists. If the aniline-dye industry has been neglected in this country, there are many good reasons for it; not only was the possibility of reasonable profits too scant to offer special inducement to clever-headed business men for risking their capital in this branch of manufacturing when they had so much better choice in other channels of enterprise, but the first raw material, suitable coal-tar, was not abundantly available here as it is in Europe, for the simple reason that this country long ago discarded the older and more expensive methods of gas manufacturing still generally used in Europe, and which give coal-tar as a by-product. The less expensive and simpler water-gas process, adopted in the United States, gives no suitable gas-tar; it is only of late, by the introduction of the by-product coke-ovens, that we can look forward to an almost illimited supply of coal-tar.

In the meantime, the German manufacturers, while possessing every opportunity and inducement for specializing in these coal-tar industries, could afford to concentrate their efforts so as to supply not only their home consumption and that of the United States, but that of the whole world, in about the same way as the United States sends to the remotest corners of the globe its sewing machines, its typewriters and its Ford cars.

Judging from the past history of the chemical industry in America, I have little doubt that the day it will be found profitable to manufacture all kinds of synthetic dyes here in the United States, instead of a few as is the case now, there will be little further delay in supplying the demand by a hustling and bustling home production.

[4] See *Metallurgical and Chemical Engineering*, Vol. XIII., No. 5, 1915, p. 277.

In fact, it is quite possible that under the present conditions this branch of manufacturing may be stimulated to the point as to result in over-production after the war is over.

If hitherto our chemists have been deficient in this special line, we can, with some satisfaction, point to better efforts in other chemical industries. For instance, it is not sufficiently known how many research chemists in our different American manufacturing establishments are busily occupied in studying and improving manufacturing processes, nor what large sums of money are devoted every year to industrial chemical research. If we hear it constantly repeated that some of the largest German chemical companies have hundreds of chemists and engineers, it is less known that right here in the United States the number of chemists employed in some of our better organized chemical enterprises is scarcely less; but nobody finds it necessary to boast about it. In fact, the most striking symptom is that so many engineering enterprises, for instance, some of our large electrical companies—although their field of action seems rather remote from chemical subjects—have now elaborate chemical research organizations with an excellent record.

Conditions were quite different some fifteen or twenty years ago; but this country has grown, and as the requirements and opportunities grew up new chemical problems arose thereby.

The urgent nature as well as the magnitude of some of these new chemical problems is shaking our chemists awake—is making new men of them.

Professor Whitaker is probably right when he says that from the standpoint of efficiency the chemists are thirty years behind the engineers as far as method and attitude of mind are concerned, but this same criticism holds good for chemists all over the world. The fact is that the engineer was called first, and he was born centuries before the chemist, but the latter is now making up for lost time.

New conditions, new problems, are compelling the chemist to learn to tackle a proposition in a true engineering spirit and —to hitch some business sense to it. He is learning to forget thinking or acting on the test-tube plan; he is thrown more and more in contact with business men; he begins to realize that too one-sided theoretical considerations are sometimes more dangerous than complete ignorance and that a sense of proportion and relative values is the first requirement for good practical effort.

Here, indeed, is one of the weakest spots of the chemist. Aside from the fact that the chemical profession seems one of those vocations which have fascinated a large number of intellectual freaks, it has generally attracted men of an analytical rather than a constructive turn of mind. Successful engineering is essentially constructive. The most urgent work for the chemist of to-day must be constructive—he must learn how to cement together the vast amount of data which already lie at his disposal, even if he himself has to provide some of this very cement by further research.

The chemist of to-day is no longer confined to purely chemical enterprises; even the most stubbornly conservative manufacturers have learned, through competition, that every industry, however mechanical be its nature, has its chemical problems. Things have changed rapidly since the day Andrew Carnegie listened with a sly twinkle in his eyes to the fun his competitors were poking at him when he first engaged a spectacled professor to investigate the chemical problems in his iron-works. Conditions have now become reversed; today, a steel or iron works without a com-

petent chemist justly provokes contempt and distrust.

Nor is the time so far distant when even our biggest railroads had not begun to realize how they missed the constant services of a staff of chemists, so as to advise them in the various chemical problems which present themselves in the operation of a well-organized railroad system.

Some time ago, I visited the plant of the National Cash Register Company, in Dayton, Ohio; one of its most interesting departments was its well-equipped chemical laboratory, where no end of chemical questions relating to the manufacture of purely mechanical devices have to be studied and solved. No up-to-date motor-car works is complete without its chemical department and the same remark holds good for all well-organized engineering concerns.

In the United States, the importance of chemistry has been appreciated first in its relation to agriculture. So obvious was this, that we set an example to all other nations of the world by the number and extent of our federal and our state chemical agricultural laboratories. This, more than anything else, was the entering wedge of applied chemistry in this country, which extended, later on, to the government service, the Geological Survey, the Bureau of Standards and the Bureau of Mines. Nor did the useful effect stop there. Many of our federal chemists, our state chemists, have left public service, to accept better paying positions in private industries; but these men trained in public service, implanted their high aims and scientific ways in some of our commercial enterprises, which needed it badly. I know of some cases where this beneficial influence changed radically the whole tone of the commercial organization, from its manufacturing to its selling department, and introduced, instead of reckless, sordid commercialism, a spirit of fairness and efficiency which soon proved the more profitable policy.

In this and similar directions the chemist can exercise a valuable moral influence on the community. If you think it over, you will find that the quest for efficiency lies close to the path of honesty, justice and equity.

Here also the chemist has much to learn. In some instances, I have been astounded at the almost childlike attitude of mind of some of our chemists who are too ready to sell their services to anybody who has a temporary use for them, irrespective of the underlying motives or purposes.

Some lawyers tell me that they never have the slightest difficulty in hiring chemical experts to defend contradictory opinions. For instance, it is quite amazing how some chemists, in their eagerness to please their employers, will overlook their own ignorance of the most elementary principles of patent law, as well as their superficial acquaintance with the many details of intricate technical questions, while not hesitating to furnish cock-sure opinions which encourage infringers or industrial pirates to trespass on the rights of intellectual property of others. Much ruinous patent litigation would be avoided in this country, and invention would be better encouraged, if we had more men of the type of that well-known British electrical expert who never hesitates in court to tell the simple and direct truth, regardless whether it kills or saves the case of his client; his statements are so highly valued and respected that the judges accept them without suspicion, and the same expert is frequently retained by the two opposing parties, whom he serves impartially, and who gladly pay him higher fees than to a mere litigation-acrobat-expert, or a chemical "ambulance-chaser."

The ethics of our profession have been

dealt with by the American Institute of Chemical Engineers, and have been embodied in its recently adopted Code of Ethics, which may furnish a good guide for younger or less experienced chemists. And this leads me to state that many more manufacturers or business men would be induced to utilize the services of chemists if they could feel confident that in so doing they are not putting themselves at the immediate mercy of a stranger, by confiding to him unreservedly facts or processes which it has cost them many sacrifices of time and money to accumulate, and the undivided knowledge of which constitutes sometimes one of their most valuable assets. On the other hand, a chemist can hardly be of any service unless his client or employer is just as frank with him as he would be with his lawyer or physician. However, this mooted point is easily overcome by referring to the Code of Ethics to which I have just alluded, or, better, by making a preliminary agreement between the chemist and his client or employer, safeguarding the interests of both parties. But in such a case, the compensation to the chemist should be made commensurate to the occasion.

This same principle holds good in the employment of chemists in manufacturing plants, where the chemist is either engaged in research or in a manufacturing capacity. An employer should not expect an intelligent chemist to render him important services without proper compensation, and in as far as the practical value of the work of a chemist can seldom be determined in advance, it will pay the employer to offer special inducements or rewards for initiative; he can well afford to give his chemist some share of the increased profits he has received through his work; to do otherwise would be narrow-minded, short-sighted and detrimental to the direct interests of the employer. The work of a research chemist can not be performed nor measured like that of a bookkeeper or a laborer; the results of his work are uncertain; delays and obstacles beset him at every turn; sometimes luck plays an important rôle; but good will, enthusiasm and persistent endeavor are indispensable factors, and these may be encouraged or killed by the attitude of the employer. An employer who is unfair, or who can not arouse the respect or the enthusiasm of his chemists, can not get the best there is in them; he must make them feel that if their work turns out well for him, they will get some fair share of compensation. Therefore, a reasonable salary ought to be supplemented by the possibility of a bonus or some share in the profits based on earnings brought about directly by the work of the chemist.

On the other hand, the chemist must not overlook the financial sacrifices and business-risks assumed by his employer. He should specially bear in mind that knowledge or experience gathered at great cost by his employer, or through expensive factory equipment, or other special facilities, have in most cases enabled him to take up his own part of the work at an advanced stage. It would be rather unfair, unless otherwise stated, that a chemist should be allowed, during or after his period of employment, to divulge or take advantage of all the confidential knowledge or information gathered around the works in which he is employed; or patent for his exclusive benefit any invention he may make on those particular subjects for which he is engaged, as long as the stimulating ideas themselves have been gathered by the very means put at his disposal by his employer. All these questions should be provided for and embodied in an equitable contract which will necessarily vary with special circumstances. But here again, niggardliness, or too great cunning-

ness of the employer, will hardly pay. Unless his chemist be a fool—and a fool of a chemist is not worth anything—his employer will lose the good will and confidence of the very man whose work is primarily dependent on these indispensable factors.

Faithful and generous observance of these conditions has brought about the most excellent results in many instances; I know that the contract system, with a salary supplemented by a bonus, or some participation in profits in special departments, has been used with great advantage to all concerned, by some of the most successful chemical companies in continental Europe and in some of the more progressive American enterprises.

It has been objected that a contract of the kind merely binds the employer who has tangible assets, while in most cases it would be difficult to enforce it against faithless employees possessing no property. But even then, a clear and well-defined contract will prevent many misunderstandings which may crop up in the course of time. It has been my experience that direct dishonesty and faithlessness are merely exceptions among chemists, whatever their other shortcomings may be.

We know where the work of the chemist begins. We can never tell where it ends and through what unexpected ramifications it may lead. It is just this fact which adds some zest to the life of the struggling, hard-working chemist, and brings to his work frequently as much excitement as the best of sports; his hopes and disappointments can be compared to those of the restless prospector.

Pasteur, while he was professor at the University of Lille, was consulted by a local alcohol distiller about some irregularities in the fermentation processes. Little did the great French chemist dream, when he tried to solve this seemingly trifling industrial problem, that by doing so he was going to lay bare such an amount of new and unsuspected scientific facts destined to upset all formerly accepted notions, not merely on fermentation, but on life, disease, contagion and epidemics; that he was about to revolutionize surgery, sanitation and medicine, and create several new departments of medical science; that he was going to save millions of lives—reduce sorrow and misery. So little were the men of that period prepared for all these stupendous revelations that this great benefactor of the human race had to suffer most from the gibes and violent attacks of some of the best known men of that very medical profession into which he was going to infuse new life by placing it on a true scientific basis. The history of the stubborn polemics and angry discussions at the French Academy show that, at that time at least, the imagination even of men of science, could not expand to the point of perceiving that medicine and surgery were to be remodeled by a mere chemist.

L. H. BAEKELAND

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

THERE were last year conferred 556 degrees of doctor of philosophy or science by institutions competent to confer these degrees. This number exceeds the number for last year by 10 per cent., and is double the average number for the decennium beginning in 1898, when these records were begun. During that decennium seven institutions conferred 2,045 degrees and the remaining 38 institutions 685 degrees. The seven institutions still lead decisively, but not to the same extent, and their grouping has been altered. In the first period, Chicago, Harvard, Columbia, Yale and Johns Hopkins each conferred an average of over 30 degrees, while the number at Pennsylvania and Cornell was in the neighborhood of 20. In the course of later years Columbia has surpassed Chicago, and Harvard has not kept equal with these two universities. Yale and Johns Hopkins have remained about stationary

and now are grouped with Pennsylvania and Cornell.

The most notable change has been the increase of advanced work in the state universities. As American students formerly went to Germany for graduate work, so for a period of years students from the central and western states came to the privately endowed eastern universities. They still do so, but the state universities now provide men and equipment making it possible to carry on research work to advantage. Last year Michigan, Illinois, California and Wisconsin each conferred over twenty degrees as compared with an average under five in the earlier period. Iowa, Nebraska and Indiana each conferred six degrees this year.

Of the 556 degrees 309 were in the natural and exact sciences, which represents a relative gain in them over the earlier period during which they were responsible for less than half of the degrees. Chemistry, as always, leads, the 85 degrees being by far the largest number conferred in any subject. Among the sciences botany and geology ranked high this year and appear to be the sciences making the most rapid gains. Botany and zoology followed chemistry and about equalled English and history.

Of 79 degrees conferred by Chicago, 53 were in the sciences; of 70 degrees conferred by Columbia, 27 were in the sciences. At Columbia and Pennsylvania 39 per cent. of all degrees have been in the sciences, at Johns Hopkins it has been 60 and at Cornell 70 per cent.

The institutions which conferred two or more degrees in a science are: *chemistry,* Columbia, 12; Johns Hopkins, 11; Chicago, 9; Yale, 8; Harvard and Illinois, 6 each; California, 5; Cornell and Pittsburgh, 4 each; Michigan, 3; Iowa, Massachusetts Institute of Technology, Minnesota, North Carolina, Pennsylvania and Stanford, 2 each; in *physics,* Harvard, 5; Cornell, 4; Chicago, Clark and Michigan, 3 each; California, Johns Hopkins, Pennsylvania, Princeton and Yale, 2 each; in *zoology,* Columbia, 5; Chicago and Harvard, 4 each; California and Wisconsin, 3 each; George Washington, Illinois, Johns Hopkins and Yale, 2 each; in *botany,* Chicago, 8; Cornell, 7; Washington, 5; California, Johns Hopkins and Pennsylvania, 3 each; Harvard, Illinois, Michigan and Nebraska, 2 each; in *psychology,* Clark, 7; Harvard, 4; Chicago, 3; Michigan, 2; in *mathematics,* Chicago, 7; Harvard, 3; Columbia, Cornell, Pennsylvania and Yale, 2 each; in *geology,* Chicago, 8; Harvard, 4; Columbia, Johns Hopkins and Wisconsin, 3 each; Indiana and Yale, 2 each; in *physiology,* Yale, 3; Chicago and Harvard, 2 each; in *agriculture,* Cornell, 5; Illinois, 4; in *astronomy,* Chicago, 3; Michigan, 2; in *bacteriology,* Brown, 4; in *anthropology,* Columbia, 3; Harvard, 2; in *anatomy,* Minnesota, 2; in *paleontology,* California, 2; in *pathology,* Chicago, 2; in *geography,* Chicago, 3.

TABLE I

Doctorates Conferred

	Average of 10 Years 1898–1907	'08	'09	'10	'11	'12	'13	'14	'15	Total 18 Years 1898–1915
Columbia	32.2	55	59	44	75	81	66	63	70	835
Chicago	35.6	54	38	42	55	57	46	61	79	788
Harvard	33.8	42	38	35	42	41	52	63	58	709
Yale	31.8	32	44	27	31	31	39	32	36	590
Johns Hopkins	30.5	28	27	23	28	32	32	30	31	536
Pennsylvania	22.5	32	29	26	29	34	31	18	34	458
Cornell	18.1	22	34	35	34	33	35	47	31	452
Wisconsin	8.6	17	16	18	23	27	19	31	21	258
New York	6.7	15	13	11	17	10	16	19	15	183
Clark	8.7	11	9	14	16	6	16	9	12	180
Michigan	6.9	4	13	7	6	11	15	7	26	158
Illinois	.5	5	4	12	11	20	20	22	23	122
California	3.3	4	10	6	6	15	10	14	22	120
Boston	4.4	11	13	6	13	8	9	5	9	118
Princeton	2.6	6	4	8	9	12	13	21	12	111
Bryn Mawr	2.1	4	2	5	5	9	3	7	2	58
George Washington	2.8	3	4	4	5	2	2	5	5	58
Brown	2.3	2	5	1	4	6	1	5	7	54
Virginia	2.8	4	1	4	2	4	4	3	2	52
Catholic	2.0	1	3	3	5	5	3	1	9	50
Minnesota	2.4	3	5	1	2	2	3	3	5	48
Stanford	1.4	2	3	5	4	4	5	5	5	47
Iowa	1.1	2	0	4	3	7	3	4	6	40
Nebraska	2.0	2	2	1	0	3	2	3	6	39
Indiana	.0	3	3	0	2	4	3	4	6	25
Radcliffe	.6	1	2	4	0	2	6	2	1	24
Mass. Inst. Tech.	.3	3	0	3	2	6	1	2	2	22
Washington	.7	1	0	0	2	1	3	1	5	20
Cincinnati	.3	0	2	2	5	3	2	2	0	19
Pittsburgh	.1	4	0	2	1	1	5	1	4	19
Missouri	.4	3	0	2	2	1	1	2	2	17
Ohio	.4	0	2	0	2	5	1	2	1	17
Vanderbilt	.6	1	1	2	0	1	2	0	1	14
Georgetown	1.0	0	0	0	0	0	0	1	1	12
N. Carolina	.5	0	1	0	0	0	0	3	2	11
Syracuse	.2	0	2	1	2	0	0	2	1	10
Colorado	.5	0	1	0	0	0	1	2	0	9
Northwestern	.4	0	1	0	1	0	0	0	3	9
Kansas	.3	0	0	3	1	0	0	0	0	7
Tufts	.5	0	0	1	0	0	0	0	0	6
Wash. and Lee	.4	1	0	0	0	0	0	0	0	5
Lafayette	.3	0	0	0	0	0	0	0	0	3
Tulane	.1	0	0	0	0	0	1	0	1	3
Dartmouth	.1	1	0	0	0	0	0	0	0	2
Lehigh	.2	0	0	0	0	0	0	0	0	2
Total	273.0	379	391	362	445	484	471	502	556	6,320

TABLE II

Doctorates Conferred in the Sciences

	Average of 10 Years 1898–1907	'08	'09	'10	'11	'12	'13	'14	'15	Total	Per Cent.
Chicago	16.4	37	20	24	35	37	16	28	53	414	53
Columbia	13.4	21	23	11	29	36	27	21	27	329	39
Johns Hopkins	16.8	17	20	15	19	23	21	18	23	324	60
Cornell	10.4	15	24	27	27	28	30	36	26	317	70
Harvard	14.1	13	14	10	20	15	22	28	33	296	42
Yale	12.4	16	27	12	15	21	19	13	20	267	45
Pennsylvania	9.0	18	13	12	10	9	9	5	11	177	39
Clark	7.7	11	8	14	16	6	13	7	10	162	90
Wisconsin	2.8	6	4	13	13	14	5	17	8	108	42
California	2.4	2	6	4	5	12	9	11	16	89	74
Illinois	.3	0	2	9	6	15	11	18	17	81	66
Michigan	2.8	1	5	1	3	8	10	5	15	76	48
Princeton	1.1	3	3	2	5	7	7	7	4	49	44
Geo. Wash't'n	1.7	2	2	3	4	2	1	2	4	37	64
Brown	1.2	2	2	1	3	4	1	4	5	34	63
Stanford	1.1	2	2	1	4	3	5	2	2	32	69
Minnesota	.7	1	2	1	2	2	2	3	4	24	50
Nebraska	1.3	1	2	1	0	0	2	1	3	23	59
Mass. Inst.	.3	3	0	3	2	6	1	2	2	22	100
New York	.6	1	3	2	1	2	3	1	3	22	12
Indiana	.0	3	3	0	2	4	1	2	4	20	80
Virginia	1.1	2	0	1	1	2	2	1	0	20	38
Washington	.7	1	0	0	2	1	3	1	5	20	100
Bryn Mawr	1.0	1	0	2	1	3	0	2	0	19	33
Iowa	.7	0	0	2	1	3	2	2	2	19	48
Ohio	.4	0	2	0	2	5	0	0	1	14	82
Cincinnati	.1	0	1	1	4	1	2	2	0	12	63
Missouri	.3	2	0	2	2	0	1	1	1	12	71
Pittsburgh	.0	0	0	1	1	1	5	0	4	12	63
Catholic	.5	—	2	0	1	1	0	0	2	11	22
Kansas	.3	0	0	3	1	0	0	0	0	7	100
N. Carolina	.3	0	1	0	0	0	0	1	2	7	64
Vanderbilt	.3	1	1	0	0	1	1	0	0	7	50
Boston	.1	0	1	0	0	1	2	0	0	5	4
Northwestern	.2	0	1	0	1	0	0	0	1	5	56
Tufts	.5	0	0	0	0	0	0	0	0	5	83
Wash. & Lee	.3	1	0	0	0	0	0	0	0	4	80
Syracuse	.1	0	0	1	1	0	0	0	0	3	30
Colorado	.2	0	0	0	0	0	0	0	0	2	22
Dartmouth	.1	1	0	0	0	0	0	0	0	2	100
Lehigh	.2	0	0	0	0	0	0	0	0	2	100
Tulane	.0	0	0	0	0	0	1	0	1	2	67
Georgetown	.1	0	0	0	0	0	0	0	0	1	50
Lafayette	.1	0	0	0	0	0	0	0	0	1	33
Radcliffe	.0	0	0	1	0	0	0	0	0	1	4
Total	124.1	184	194	180	239	273	234	241	309	3,095	49

TABLE III

Doctorates Distributed According to Subjects

	Average of 10 Years 1898–1907	'08	'09	'10	'11	'12	'13	'14	'15	Total
Chemistry	32.3	54	43	48	68	78	68	71	85	838
Physics	15.5	22	25	25	33	30	22	23	31	366
Zoology	15.2	25	18	25	25	20	26	25	32	348
Botany	12.6	11	16	10	20	30	28	34	40	315
Psychology	13.5	23	21	20	23	29	24	12	22	309
Mathematics	12.1	23	14	23	25	22	21	25	23	297
Geology	7.1	5	13	10	15	23	14	13	26	190
Physiology	4.1	7	13	4	2	12	2	8	8	97
Agriculture	1.0	2	7	4	11	11	8	9	9	71
Astronomy	3.4	1	7	3	4	2	11	2	7	71
Bacteriology	1.4	1	5	1	4	6	3	6	4	44
Anthropology	1.0	4	4	2	2	0	3	2	6	33
Anatomy	.9	2	0	1	1	6	1	2	5	27
Paleontology	1.6	1	0	2	0	0	0	4	2	25
Engineering	.8	0	0	1	2	2	0	4	2	19
Pathology	.5	2	3	1	1	2	2	1	2	19
Mineralogy	.6	0	3	0	1	0	0	0	1	11
Geography	.1	1	1	0	1	0	1	0	3	8
Metallurgy	.3	0	1	0	1	0	0	0	1	6
Meteorology	.1	0	0	0	0	0	0	0	0	1
Total	124.1	184	194	180	239	273	234	241	309	3,095
English		30	28	32	35	32	42	42	38	279
History		32	22	25	28	20	26	36	34	223
Economics		17	42	7	17	26	16	27	22	174
Philosophy		25	15	20	26	15	22	19	25	167
Education		6	9	13	23	21	25	27	26	150
German		14	14	16	8	15	23	23	23	136
Latin		13	12	16	13	17	19	16	15	121
Sociology		6	6	14	18	12	11	22	16	105
Romance		12	16	6	12	15	9	15	7	92
Political Science		9	4	9	6	9	15	7	11	70
Oriental		9	15	11	1	10	8	2	10	66
Greek		13	11	5	7	5	8	10	5	64
Theology		7	2	1	7	7	6	8	8	46
Philol. and Comp. Lit.		0	1	5	1	2	4	2	0	15
Law		1	0	1	2	1	1	3	2	11
Classical Archeology		0	0	0	1	3	1	1	4	10
Fine Arts		0	0	0	0	1	1	1	1	4
Music		1	0	1	1	0	0	0	0	3
Total		195	197	182	206	211	237	261	247	1,736

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

UNIVERSITY OF CHICAGO

Hanna Caroline Aase: "Vascular Anatomy of the 'Megasporophyll' in Conifers."

Edward Moore Jackson Burwash: "The Geology of Vancouver and Its Surroundings."

Joseph Stuart Caldwell: "A Study of the Effects of certain Antagonistic Solutions upon the Growth of Zea mays."

John William Campbell: "Periodic Solutions of the Problem of Three Bodies in Three Dimensions."

Joel Ernest Carman: "The Pleistocene Geology of Northwestern Iowa."

Elizabeth Caroline Crosby: "The Telencephalon of Alligator Mississippiensis."

Hermann Bacher Deutsch: "Effect of Light upon the Germination of the Spores of the True Ferns."

Charles Ross Dines: "Functions of Positive Type and Related Topics in General Analysis."

Ellsworth Faris: "The Psychology of Punishment."

Mary Louise Foster: "Studies on a Method for the Quantitative Estimation of Certain Groups in Phospholipins."

Meyer Grupp Gaba: "A Set of Postulates for General Projective Geometry of '*n*' Dimensions."

Walter Lee Gaines: "A Contribution to the Physiology of Lactation."

James Frederick Groves: "Life Duration of Seeds."

Olive Clio Hazlett: "On the Classification and

Invariantive Characterization of Nilpotent Algebras.''

Oscar Fred Hedenburg: ''On the Esters, as well as the Monomolecular *B*- and *y*-Lactones of *d*-Mannonic and *d*-Gluconic Acids; On Ortho-Bis-*d*-Galactonic Acid, *d*-Galactonic *y*-Lactone and Its Mono-Hydrate.''

Lewis Victor Heilbrunn: ''Studies in Artificial Parthenogenesis: II. Physical Changes in the *Arbacia* Egg.''

Albert Edward Hennings: ''A Study of the Contact Potentials and Photo-Electric Properties of Metals in Vacuo.''

Edwin Frederick Hirsch: ''An Experimental Study of the Influence of Iodin and Iodides on the Absorption of Granulation Tissue and Fat-free Tubercle Bacilli.''

Louis Allen Hopkins: ''On the Theory of the Motion of the Small Planets with a Periodic Orbit for the Hilda Type.''

Edmund Charles Humphrey: ''Surface Tension at the Interface between Two Liquids.''

Andrew Henderson Hutchinson: ''Fertilization in *Abies balsamea.*''

Libbie Henrietta Hyman: ''An Analysis of the Process of Regeneration in Certain Microdrilous Oligochætes.''

Wellington Downing Jones: ''Geography of Northern Patagonia.''

Frank Craig Jordan: ''The Color Changes of Certain Variable Stars of Short Period.''

George Frederick Kay: ''The Geology and Ore Deposits of Riddle's Quadrangle, Oregon.''

Charles Edwin King: ''The Origin of the Diastases of the Blood and the Lymph.''

Harold Reynolds Kingston: ''Metric Properties of Nets of Plane Curves.''

Harry Dexter Kitson: ''The Scientific Study of the College Student.''

Francis Leroy Landacre: ''The Origin of the Cranial Ganglia in *Ameiurus.*''

John Yiu-Bong Lee: ''The Determination of '*e*' by the Small-Drop Method Using Solid Spheres.''

James Henry Lees: ''The Geological History of the Des Moines Valley.''

Edwin Daniel Leman: ''The Relation between the Alpha-Ray Activities and Ranges of Radioactive Substances.''

Julian Herman Lewis: ''The Absorption of Substances Injected Subcutaneously and the Inhibitory Action of Heterologous Protein Mixtures on Anaphylaxis.''

William Vernon Lovitt: ''A Type of Singular Points for a Transformation of Three Variables.''

Bertha Edith Martin: ''Tooth Development in *Dasypus novemcinctus.*''

Kirtley Fletcher Mather: ''The Fauna of the Morrow Group of Arkansas and Oklahoma.''

Agnes Fay Morgan: ''I. Viscosities of Various Methyl and Ethyl Imido-benzoates and of the Sodium Salts of Para and Meta Nitrobenzoylchloroamides in Moderately Concentrated Aqueous Solutions. II. The Molecular Rearrangement of Some Triaryl Methylchloroamines.''

Roberts Bishop Owen: ''The Psychology of Recognition.''

Harry Morrill Paine: ''The Effects of Salts on the Solubility of Other Salts: I. The Solubility Relations of a Very Soluble Bi-univalent Salt. II. The Ionization of Bi-bivalent Salts.''

Almon Ernest Parkins: ''The Historical Geography of Detroit.''

Harley Martin Plum: ''The Extraction and Separation of the Radioactive Constituents of Carnotite.''

Vincent Collins Poor: ''A Certain Type of Exact Solution of the Equations of Motion of a Viscous Liquid.''

Terence Thomas Quirke: ''Geology of Espanola District.''

Isaiah March Rapp: ''Flow of Air through Capillary Tubes.''

George Burton Rigg: ''Decay and Soil Toxins.''

Eva Ormenta Schley: ''Physical and Chemical Changes Involved in Geo-presentation and Geo-reaction.''

Luther Crocker Snider: ''The Geology and Paleontology of the Mississippian Rocks of Northwestern Oklahoma.''

Bert Allen Stagner: ''On the Molecular Rearrangements of Triarylmethyl Hydroxylamines.''

Eugene Austin Stephenson: ''Hydrothermal Alteration of Feldspars.''

James Palm Stober: ''A Comparative Study of Winter and Summer Leaves of Various Herbs.''

Clare Christman Todd: ''The Action of Alkaline Hydrogen Peroxide on *d. Galactose.*''

Stephen Sargent Visher: ''The Geography of South Dakota.''

Forbes Bagley Wiley: ''Proof of the Finiteness of the Modular Covariants of a System of Binary Forms and Cogredient Points.''

HARVARD UNIVERSITY

Frederick Osband Anderegg: I. A Contribution to the Study of the Silver Coulometer. II.

The Activities of Concentrated Chloride Solutions from the Electromotive Forces of Silver Concentration-cells. III. The Investigation of the Electromotive Forces of Concentration-cells involving Alloys of Tin and Cadmium and a Fused Electrolyte.''

Leslie Brainerd Arey: ''The Movements in the Visual Cells and Retinal Pigment of the Lower Vertebrates.''

Edward Payson Bartlett: I. ''A Study of certain Oxidation Potentials.'' II. ''The Compressibility of certain Elements and Compounds.''

James Winfred Bridges: ''An Experimental Study of Decision Types and their Mental Correlates.''

Harold Ernest Burtt: ''Factors Influencing the Arousal of the Primary Visual Memory Image.''

Thorne Martin Carpenter: ''A Comparison of Methods for Determining the Respiratory Exchange in Man.''

William John Crozier: ''Studies on Sensory Stimulation.''

Wilbur Garland Foye: ''The Glamorgan Gabbro Body and its Associated Rocks.''

Robert Gorham Fuller: ''Observations on a Collection of Crania from the Prehistoric Stone Graves of Tennessee.''

Irvine Clifton Gardner: ''Metallic Reflection in the Region of extremely Short Wave Lengths.''

Fred Leslie Grover: ''The Atomic Weight of Lead.''

Frederick Simonds Hammett: ''Uric Acid in Tissues.''

Gorham Waller Harris: ''A Revision of the Atomic Weight of Arsenic and Further Applications of the Method of Floating Equilibrium.''

Miner Ludwig Hartmann: ''I. The Free Energy of the Formation of Silver. II. The Atomic Weight of Cadmium.''

Charles Ruglas Hoover: ''The Atomic Weights of Iron, Carbon and Sulphur.''

Max Mayo Miller: ''A Study of the Hypophysis Cerebri in the Pig.''

William Edmund Milne: ''On the Degree of Convergence of Birkoff's Series.''

Joseph Murdoch: ''The Microscopic Determination of the Opaque Minerals: A Contribution to the Study of Ores.''

Christian Nusbaum: ''Eddy Current and Hysteresis Losses in Iron at High Frequencies.''

Sidney Powers: ''The Acadian Triassic.''

Guilford Bevil Reed: ''Studies in Plant Oxidases.''

William Rees Brebner Robertson: ''Chromosome Studies: I. Taxonomic Relationships shown in the Chromosomes of the Tettigidæ and other Sub-families of Acrididæ: V-shaped Chromosomes and their Significance in Acrididæ, Locustidæ, and Gryllidæ: Chromosomes and Variation. III. Inequalities and Deficiencies in Homologous Chromosomes: their Bearing upon Synapsis and the Loss of Unit Characters.''

Arnold Romberg: ''The Ratio of the Calorie at 73° to that at 20°.''

Paul Earls Sabine: ''The Energy of Photoelectrons as a Function of the Frequency for Light of extremely Short Wave Lengths.''

Ellis William Shuler: ''The Geology of the Walker Mountain Overthrust Block in Southwestern Virginia.''

Francis Briggs Silsbee: ''A Study of the Inductance of Four-terminal Resistance Standards.''

Frederick Henderscn Sterns: ''The Archeology of Eastern Nebraska, with special Reference to the Culture of the Rectangular Earth Lodges.''

Edward Chace Tolman: ''Studies in Memory.''

Leonard Thompson Troland: ''Studies of Visual Equilibria.''

David Henry Wenrich: ''The Spermatogenesis of *Phrynotettix magna*, with special Reference to Synapsis and the Individuality of the Chromosomes.''

William Henry Weston, Jr.: ''On the Development of *Thraustotheca*, with a Comparative Examination of *Dictyuchus*.''

Charles Edward Wilder: ''Problems in the Theory of Ordinary Linear Differential Equations with Auxiliary Conditions at more than Two Points.''

Levi Thomas Wilson: ''Conformal Transformation of Curvilinear Angles.''

COLUMBIA UNIVERSITY

Leverett Allen Adams: ''Philogeny of the Jaw-muscles in Recent and Fossil Vertebrates.''

Clive Morris Alexander: ''The Time Factor in making Oil Gas.''

Everend Lester Bruce: ''Geology and Ore Deposits of the Rossland District, B. C.''

Fay-Cooper Cole: ''A Study of Tingrican Folklore.''

Clarke Edwin Davis: ''The Surface Tension of Sulphuric Water Mixtures.''

Pauline Hamilton Dederer: ''Oogenesis in *Philosamia Cynthia*.''

John Smith Dexter: ''The Analysis of a Case of continuous Variation in *Drosophila* by a Study of its Linkage Relations.''

Arthur Donaldson Emmett: "Metabolism Studies of Fatigue, Rest and Recuperation."

Frederick Grosvenor Goodridge: "Bio-chemical Studies of Mercaptan."

Edward Gray Griffin: "Inosite and Pinite and some of their Derivatives."

Herman Karl Haeberlin: "The Idea of Fertilization in the Culture of the Pueblo Indians."

Mildred Albro Hoge: "The Influence of Temperature on the Development of a Mendelian Character."

Samuel L. Hoyt: "Copper Alloys."

Roscoe Raymond Hyde: "Sterility and Fertility in *Drosophila ampelophila*."

Israel Jacob Kligler: "Biochemical Studies and Differentiation of Oval Bacteria with special reference to Dental Caries."

Robert Hamilton Lombard: "The Densities and Degrees of Dissociation of the Saturated Vapors of the Ammonium Halides and the Related Thermal Data."

Alexander Lowy: "The Preparation, Properties and Composition of Silundum."

Melvin Albert Martin: "The Transfer-effects of Practise in Cancellation Tests."

Charles Craig Mook: "A Study of the Morrison Formation."

Dora Estelle Neun: "An Examination of Certain Methods for the Study of Proteolytic Action."

George Adam Pfeiffer: "Contributions to the Conformal Geometry of Analytic Arcs."

Percy Withers Punnett: "A Study of the Products of the Action of Different Amylases."

Caroline Eustis Seely: "Certain Non-linear Integral Equations."

Arthur Percival Tanberg: "Experiments on the Amylase of *Aspergillus Orygal*."

Arthur Waldorf Spittell Thomas: "The Influence of Certain Acids and Salts upon the Activity of Malt Amylase."

Francis Maurice Van Tuyl: "The Origin of Dolomites."

Thomas Talbot Waterman: "The Explanatory Element in the Folk Tales of the North American Indians."

CORNELL UNIVERSITY

Elmer Eugene Barker: "Heredity Studies in the Morning Glory (*Ipomea purpurea*)."

Harry Phillip Brown: "Growth Studies in Forest Trees."

Josephine Nash Curtis: "Duration and the Temporal Judgment."

Alan Estis Flowers: "Viscosity Measurement and a New Viscosimeter."

Harvey Nicholas Gilbert: "The Copper Lakes of Eosin."

Ralph John Gilmore: "Variation in the Attachment of the Pelvic Girdle in *Diemictylus vidiscens*, Rafinesque."

Horace Leonard Howes: "The Fluorescence of Some Frozen Solutions of the Uranyl Salts."

Robert Waldo King: "A Method of Measuring Heat Conductivities."

Millard Alschuler Klein: "Studies in the Drying of Soils."

Carl Edwin Ladd: "Cost Accounts on Some New York Farms for 1912–13."

Ira Elver Lee: "Pressure, Temperature and Concentration Relations in the Systems of Sodium Chloride, Ammonia; Sodium Bromide, Ammonia; and Sodium Iodide, Ammonia."

Leonard Amby Maynard: "The Fixation of Nitrogen by Sweet Clover."

Carleton Friend Miller: "Electrolysis of Certain Inorganic Salts in Liquid Ammonia."

George Adin Osner: "Leaf Smut of Timothy."

James Kemp Plummer: "The Effect of Oxygen and Carbon Dioxide on Nitrification and Ammonification in Soils."

Carleton Elderkin Power: "The Effects of Temperature upon the Phosphorescence of Certain Sulphides."

William Jacob Robbins: "Digestion of Starch by *Penicillium* (*Camembertii*)."

Joseph Rosenbaum: "The Phytophthora Disease of Ginseng. Plant Pathology."

Joseph Rosenbaum: "On Mixed Linear Equations over a Two-Dimensional Region."

Peter Juriaan van der Heyde Schreuder: "The Cape Horse—Its Origin, Breeding and Development in the Union of South Africa."

Constantine Demetry Sherbakoff: "Fusaria of Potatoes."

Ransom Evarts Somers: "Copper Deposits of the Burro Mountains."

Arthur Lee Thompson: "The Cost of Producing Milk on 174 Farms in Delaware Co., N. Y."

Carl Joseph West: "On Certain Formulas for Representing Statistical Data."

James Kennith Wilson: "Physiological Studies of *Bacillus radicola* of Soy Bean (*Sojus max* Piper) and of Factors Influencing Nodule Production."

Peter Irving Wold: "The Hall Effect and Allied Phenomena in Tellurium."

THE JOHNS HOPKINS UNIVERSITY

Walter Hatheral Coolidge: "Osmotic Pressure Measurements of Glucose Solutions at 10° and 20°."

Grace Adelaide Dunn: "A Study of the Development of *Halosaccion Ramentaceum.*"

Arthur Feddeman Gorton: "Reflection from, and Transmission through, Rough Surfaces."

James Eugene Levering Holmes: "The Difference in Chemical Behavior of Free and Combined Water as Illustrated by the Saponification of Esters."

Marion Byrd Hopkins: "The Chlorides of Orthosulphobenzoic Acid."

Helen B. Hubbert: "The Effect of Age on Habit Formation in the Albino Rat."

Edward Olson Hulburt: "The Reflecting Power of Metals in the Ultra-violet Region of the Spectrum."

Howard Huntley Lloyd: "A Study of the Conductivity of Certain Organic Acids in Absolute Ethyl Alcohol at 15°, 25° and 35°."

Forman Taylor McLean: "A Preliminary Study of Climatic Conditions in Maryland as Related to the Growth of Soy Bean Seedlings."

Austin Ralph Middleton: "Heritable Variations and the Results of Selection in the Fission Rate of *Stylonychia Pustulata.*"

Ellis Miller: "A Study of the Vapor Pressure of Aqueous Solutions of Potassium Chloride by an Improved Static Method."

Richard Nicholas Mullikin: "A Study of the Vapor Pressure of Aqueous Solutions of Mannite by an Improved Static Method."

Amos Sentman Musselman: "Osmotic Pressure Measurements of Glucose Solutions at 30°, 40°, 50° and 60°."

Robert Milton Overbeck: "The Copper Ores of Maryland."

Max G. Paulus: "Radiometric Measurements of the Ionization Constants of Methyl Orange and Phenolphthalein."

Lyde Stuart Pratt: "The Esterification of Benzoic Acid by Mercaptans."

Willis S. Putnam: "I. The Conductivity and Viscosity of Certain Rubidium and Ammonium Salts in Ternary Mixtures of Glycerol, Acetone and Water at 15°, 25° and 35°. II. The Conductivity and Viscosity of Solutions of Binary and Ternary Salts in Formamid."

John Bernard Reeside, Jr.: "The Helderberg and Tonoloway Formations of Central Pennsylvania."

John Wesley Shive: "A Study of Physiological Balance in Nutrient Media Resulting in a Simplified Culture Solution for Plants."

Clarence Piersall Sousley: "Invariants and Covariants of the Cremona Hexahedral Form of the Cubic Surface."

Ruth Jennings Stocking: "Inheritance and Variation in Abnormalities occurring after Conjugation in *Paramecium Caudatum.*"

Benjamin Franklin Wallis: "The Geology and Economic Value of the Wapanucka Limestone of Oklahoma."

Charles Watkins: "The Conductivity, Percentage Dissociation and Temperature Coefficients of Some Rather Unusual Salts in Aqueous Solution."

YALE UNIVERSITY

Frederick James Alcock: "The Geology of the Lake Athabaska Region."

Stanley Crittenden Ball: "The Natural History and Embryology of the Rhabdocœle *Paravortex Gemellipara.*"

Joseph Sumner Bates: "The Synthesis of Dipeptide-Hydantoins, together with a short study of Michigan Hard-wood Tar."

Emil Jacob Baumann: "The Question of Fat Absorption from the Stomach."

Harold Saxton Burr: "The Effect of the Removal of the Nasal Pits on the Behavior, and on the Development of the Head, of *Amblystoma.*"

Isaac Faust Harris: "Chemical and Physiological Studies of the Castor Bean and Soy Bean."

Henry Benjamin Hedrick: "Some Principles and Processes in the Construction of Mathematical Tables."

Byron Murray Hendrix: "Studies in the Physiological Action of Some Protein Derivatives."

Henry Daggett Hooker, Jr.: "Thermotropism and Hydrotropism."

Edward Frederick Kohmann: "The Constitution of Mono- and Dinitrotyrosine, and the Xanthoproteic and Millon's Reactions."

John Milton Miller: "The Effective Resistance and Inductance of Iron and Bimetallic Wires."

Harley Dyer Minnig: "A Method for the Separation of Aluminium from Iron and Beryllium."

Robert Alexander Patterson: "The Structure of the Third Cyanogen Band."

John Henry Reedy: "Anodic Potentials of Silver."

Paul Reece Rider: "An Extension of Bliss's Form of the Problem of the Calculus of Variations, with Applications to the Generalization of Angle."

Blair Saxton: "The Nature of Certain Precipitated Inorganic Colloids."

Walter Moody Scott: "The Hydroxyl Derivatives of Phenylalanine, and their Biochemical Interests."

Raymond Louis Stehle: "The Rôle of the Digestive Glands in the Excretion of Endogenous Uric Acid."

Richard Wrenshall: "Synthesis of α-Amino-δ-Phenylvalerianic Acid."

William Josiah Wright: "Geology of the New Ross Map-Area, with an Introductory Chapter on the Gold-bearing Series and the Granites of Southern Nova Scotia."

UNIVERSITY OF ILLINOIS

Demetrius Ion Andronescu: "The Physiology of the Pollen of *Zea Mays* with Special Regard to Vitality."

Albert John Becker: "The Strength and Stiffness of Steel under Bi-Axial Loading."

William Leonidas Burlison: "Availability of Mineral Phosphates for Plant Nutrition."

Harry Peach Corson: "Manganese in Water Supplies."

Oscar Edward Harder: "Alloys of Chromium, Copper and Nickel."

Joseph Whitney Howard: "The Rearrangement of Alkyl Anilines."

Lloyd Theodore Jones: "An Experimental Verification of the Law of Variation of Mass with Velocity for Cathode Rays."

Oliver Kamm: "The Structure of the Dihydro-B-Naphthoic Acids and the Correlation of Ionization and Structure in Unsaturated Acids."

Wallace Macfarlane: "Solubility of Lime Carbonates in Relation to Their Endurance in Soils."

Harold Hanson Mitchell: "Feeding Experiments on the Substitution of Proteins by Definite Mixtures of Isolated Amino Acids."

Edna Mosher: "A Classification of the Lepidoptera Based on Characters of the Pupa."

Fred Weaver Muncie: "The Effect of Large Applications of Commercial Fertilizers upon Carnations."

George Leo Peltier: "Parasitic Rhizoctonias in America."

George Rutledge: "The Number of Abelian Subgroups of Groups whose Orders are the Powers of Primes."

Minnie Elizabeth Watson: "Studies on Eugregarines Including Descriptions of Seventeen New Species and a Synopsis of the Eugregarine Records from the Myriapoda, Coleoptera and Orthoptera of the World."

Morris Miller Wells: "The Relation of Fishes to Ions in their Natural Environment. I. Reactions and Resistance to Acidity, Alkalinity, and Neutrality. II. Reaction and Resistance to Salts."

Frank Archibald Wyatt: "The Influence of Calcium and Magnesium Compounds on Plant Growth."

UNIVERSITY OF CALIFORNIA

William Lind Argo: "The Potential of the Rubidium Electrode."

Gerald Eyre Kirkwood Branch: "The Free Energy of Formation of Formic Acid."

Oscar Leo Brauer: "The Rate of Conversion of Cinchonine into Cinchotoxine."

John Peter Buwalda: "A New Mammalian Fauna from Miocene Sediments near Tehachapi Pass on the Summit of the southern Sierra Nevada."

Lee Raymond Dice: "Distribution of the Land Vertebrates of southeastern Washington."

Helen Margaret Gilkey: "A Revision of the Tuberales of California."

Richard Morris Holman: "The Orientation of Terrestrial Roots with Particular Reference to the Medium in which they are Grown."

William Noble Lacey: "The Free Energy of Formation of Carbon Oxysulphide."

Seth Barnes Nicholson: "Discovery, Observations and Orbit of the Ninth Satellite of Jupiter."

Earl Leroy Packard: "Faunal Studies in the Cretaceous of the Santa Ana Mountains of Southern California."

Frederick Eugene Pernot: "Alternating and Transient Currents in Coupled Electrical Circuits."

Charles Walter Porter: "Temperature Coefficients and the Effects of Acids, Bases and Neutral Salts in Reaction Velocities of the Triphenylmethane Dyes."

Arthur Herbert Saxer: "The Nature and the Velocity of Migration of the Positive Ions in Flames."

Olive Swezy: "The Kinetonucleus of Flagellates and the Binuclear Theory of Hartmann."

Charlie Woodruff Wilson: "On the Life-history of a Soil Amœba."

Harry Stanley Yates: "The Comparative Histology of Certain California Boletaceæ."

UNIVERSITY OF MICHIGAN

Ernest Franklin Barker: "Selective Radiation from Osmium Filaments."

William Howard Batson: "Acquisition of Skill."

George Herbert Coons: "A Study of the Fac-

tors Involved in the Growth and Pycnidia Formation of *Plenodromus Fusco-Maculans.*''

George Morris Curtis: ''The Morphology of the Mammalian Seminiferous Tubule.''

Floyd Carlton Dockeray: ''The Effects of Physical Fatigue upon Mental Efficiency.''

Alfred Lynn Ferguson: ''Activity and Concentration, Transport Numbers and Boundary Potential.''

Chester Hume Forsyth: ''Vital and Monetary Losses in the United States Due to Preventable Deaths.''

Laurence Hadley: ''A Study of ζ Ursæ Majoris.''

William Vernor Hoyt: ''The Constitution of the Nitro-α-Carbopyrrolic Acids.''

Walter Fred Hunt: ''The Origin of the Sulphur Deposits of Sicily.''

Robert Lee Jickling: ''Thiophene Analogs of Triphenyl-methyl.''

Carleton Volney Kent: ''The Optical Constants of Liquid Alloys.''

Adrian John Pieters: ''The Relation between Vegetative Vigor and Reproduction in some Saprolegniaceæ.''

Daniel Leslie Rich: ''Oscillatory Spark Discharges between Unlike Metals.''

Will Carl Rufus: ''The Spectra of Stars belonging to Class R of the Draper Classification.''

UNIVERSITY OF PENNSYLVANIA

William Henry Adolph: ''A Study of the Quantitative Methods for Fluorine.''

Thomas Rush Alexander, Jr.: ''The Quantitative Determination of Chromium.''

Krikoris Garabed Bohjelian: ''Observation and Reduction of Occultations of Stars by the Moon.''

Thomas Darlington Cope: ''An Application of the Radiometer to the Measurement of Electric Current.''

Ernest William Hawkes: ''Skeletal Measurements and Observations on the Point Barrow Eskimo with Comparisons with Other Eskimo Groups.''

Louis Kossuth Oppitz: ''Optical Constants of the Binary Alloys of Silver with Copper and Platinum.''

John Young Pennypacker: ''Observations on the Beach Plum: A Study in Plant Variation.''

Henry Ferris Price: ''Fundamental Regions for Certain Finite Groups in Two Complex Variables.''

Lowell Jacob Reed: ''Some Fundamental Systems of Formal Modular Invariants and Covariants.''

David Walter Steckbeck: ''Comparative Histology and Irritability of Sensitive Plants.''

Heber Wilkinson Youngken: ''The Comparative Morphology, Taxonomy and Distribution of the Myricaceæ of the Eastern United States.''

CLARK UNIVERSITY

Charles Lewis Brightman: ''Thermo-elastic Relations in Steel in the Region of Recalescence.''

Burchard Woodson DeBusk: ''The Vital Index in Relation to Development.''

Elmer Adna Harrington: ''The Dielectric Constant of Aqueous Solutions.''

William Henry Hayes: ''Religion as a Psychic Factor in Social Development.''

Yoshihide Kubo: ''Some Aspects of Recent Child Study.''

William Thomas Sanger: ''A Study of Senescence.''

George Samuel Snoddy: ''An Analysis of Trial and Error Learning in the Human Subject.''

Harold Frederic Stimson: ''Elastic Hysteresis in Metal Diaphragms.''

Raymond Holder Wheeler: ''An Experimental Investigation of the Process of Choosing.''

Edward Clinton Wilson: ''The Psychology of the Story.''

UNIVERSITY OF WISCONSIN

Nathan Fasten: ''Gametogenesis in the Crustacea.''

Edmund Cecil Harder: ''Contact Metamorphism as represented by Various Iron Ore Deposits.''

John Nicholas Lowe: ''Action of Chemical Stimuli on the Chromatophores of the Brook Trout *Salvelinus fontinalis mitchill.*''

Charles August Mann: ''Chemistry of San Palmetto Berries.''

Howard Edward Pulling: ''The Movement of Water in Aerotid Soils.''

Elizabeth Anita Smith: ''Spermatogenesis of the Dragon Fly *Sympetrum semicenctum* (Say).''

Thomas Leslie Tanton: ''The Relative Importance of Meteoric and Magmatic Waters in the Deposition of Certain Primary Ores.''

William Lawrence Uglow: ''A Study of Methods of Mine Assessments and Valuation.''

BROWN UNIVERSITY

Ralph Gibney Hurlin: ''The Histogenesis and Distribution of the Connective Tissue Pigmentation of the Silky Fowl.''

Benjamin Samuel Levine: "The Removal of Natural Impurities of Cotton Cloth by Action of Bacteria."

Courtland Sawin Mudge: "The Effect of Sterilization on the Sugars of Culture Media."

George Hathorn Smith: "The Parenteral Digestion of Bacterial Protein."

Albert Whitman Sweet: "A Sanitary Survey of the Seekonk River."

WASHINGTON UNIVERSITY

Alva Raymond Davis: "Enzyme Action in the Marine Algæ."

William Harrison Emig: "The Occurrence in Nature of certain Fungi Pathogenic for Man and the Higher Animals."

Joseph Charles Gilman: "Cabbage Yellows and the Relation of Temperature to its Occurrence."

Melvin Clarence Merrill: "The Electrolytic Determination of Exosmosis from the Roots of Plants Subjected to the Action of Various Agents."

Lee Oras Overholts: "Comparative Studies in the Polyporaceæ."

GEORGE WASHINGTON UNIVERSITY

Maurice Crowther Hall: "Nematodes of Rodents."

Samuel Palkin: "Investigation of the Halogen Derivatives of the Pyrazolons and the Determination of Antipyrene in Mixtures."

Joseph Duerson Stout: "Studies of the Functions of the Cerebral Motor Cortex of the Cat."

Charles Henry Tyler Townsend: "Contribution to a Thorough Knowledge of the Muscoid Flies; On the Female-reproductive and Early-stage Characters as indicating Phylogeny and a Basis for Taxonomy, together with a Consideration of Host Relations, General Bionomics and Distribution."

INDIANA UNIVERSITY

Halbert Pleasant Bybee: "The Flood of 1913 in the Lower White River Region of Indiana."

John Benjamin Dutcher: "The Nature of the Explosion Wave in an Electrolytic Gas."

Grover Cleveland Mance: "Power Economy and the Utilization of Waste in the Quarry Industry of Indiana."

Fermen Layton Pickett: "*Arisæma triphyllum*: A Biological Study."

UNIVERSITY OF MINNESOTA

William Fitch Allen: "The Spinal Cord of *Bdellostoma*."

Edwin Baumgartner: "Development of the Liver, Gall Bladder and Hepatic Ducts in *Amblystoma punctatum*."

Morris Joslin Blish: "The Chemical Constitution of Wheat Proteins and Their Relation to Baking 'Strength' in Flour."

Sterling Nelson Temple: "Equilibria in Systems of the Higher Alcohols, Water and Salts."

UNIVERSITY OF PITTSBURGH

Raymond Augustine Dumphy: "Partial Vapor Pressures and Distillation."

Sidney Liebovitz: "Theory of Esterification."

Harold Arthur Morton: "Specific Rotary Power of Organic Substances."

Joshua Chitwood Witt: "Oxidation and Reduction without Addition of Acid."

PRINCETON UNIVERSITY

Albert Arnold Bennett: "An Algebraic Treatment of the Theorem of Closure."

Henry Higgins Lane: "The Correlation between Structure and Function in the Development of the Special Senses of the White Rat."

Horace Hardy Lester: "The Determination of the Work Function, when an Electron Escapes from the Surface of a Hot Body."

Keith Kuenzi Smith: "Negative Thermionic Currents from Tungsten."

UNIVERSITY OF NEBRASKA

Richard Hans Boerker: "Ecological Investigations with Certain Forest Trees."

George Borrowman, Jr.: "The Clays of Nebraska."

Clarence Jerome Elmore: "The Diatoms (Bacillarioireæ) of Nebraska."

NEW YORK UNIVERSITY

Alphonse Andrew Adler: "A Method of Measuring Capillarity at Varying Temperatures."

Frank Owen Amon: "The Effect of Acids on the Solubility of Electrolytes."

John Hudson Ballard: "Some Phases of the Psychology of Puzzle Learning."

CATHOLIC UNIVERSITY

Daniel Da Cruz: "A Contribution to the Life History of *Lilium Tennifolium*."

Othmar Frederick Knapke: "A History of the Theory of Sensation from St. Augustine to St. Thomas."

UNIVERSITY OF IOWA

Edward X. Anderson: "Electrical Conductivity of Certain Salts of Pyridine Solutions."

Perry Avery Bond: "4-nitro-5-methyl-2-sulphobenzoic Acid and some of its Derivatives."

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Frederic Hastings Smyth: "The Potential of the Bismuth Electrode and of Sodium Lead Compounds in Liquid Ammonia Solutions."

Louis Weisberg: "The Equilibrium of the Reaction between Carbon and Ammonia at High Temperatures; a Study of the Free Energy of Dilution of Hydrochloric Acid."

UNIVERSITY OF NORTH CAROLINA

Victor Clyde Edwards: "1-, 4-, 5-, 6-tetrahydroxynaphthalene. I. A New Case of Desmotropy. II. A Series of Bromine Derivatives."

William Lewis Jeffries: "The Function of 'Cooking' Fossil Resins in Varnish Manufacture."

STANFORD UNIVERSITY

Elton Marion Hogg: "Studies on the Passive State of Iron."

Roland Neal: "Colloidal Solutions of Copper Sulphide."

UNIVERSITY OF MISSOURI

Eula Adeline Weeks: "A Symmetrical Generalization of the Theory of Functions."

NORTHWESTERN UNIVERSITY

Siegel Buckborough: "The Structure of Maltose and its Oxidation Products with Alkaline Peroxide of Hydrogen."

OHIO STATE UNIVERSITY

John Bernard Parker: "A Review of North American Bombicini."

TULANE UNIVERSITY

Willard Van Orsdel King: "The Mosquitoes of New Orleans and Vicinity."

THE TRUSTEES OF THE UNIVERSITY OF PENNSYLVANIA ON ACADEMIC FREEDOM

THE following resolution was offered by Mr. Wharton Barker at the October meeting of the board of trustees of the University of Pennsylvania, and was unanimously adopted:

Because a university has three duties to perform:

1. To aid students to acquire knowledge of information heretofore gathered.

2. To make investigation in every department of human knowledge without restriction.

3. To cause publication of the result of this investigation both within and without the university:

Resolved, That the trustees of the University of Pennsylvania adopt and declare as an adequate expression of their views and purpose the statement of Thomas H. Huxley upon his installation as rector of Aberdeen University in 1874:

"Universities should be places in which thought is free from all fetters, and in which all sources of knowledge and all aids of learning should be accessible to all comers, without distinction of creed or country, riches or poverty."

The following resolution was offered by Mr. Effingham B. Morris, and was unanimously adopted:

In order to avoid misunderstanding of the position of the university toward freedom of academic opinions, speech, teachings and public discussions, by members of its faculties, this minute is entered upon the records of the board of trustees.

Under the original charter and statutes of the university, the trustees are charged with the duty and responsibility of selecting and appointing fit persons as professors to instruct students. Because of the decision of the board at its last meeting not to renew Dr. Scott Nearing's contract of employment as an assistant professor in the Wharton School—which expired by its terms at the end of the academic year—an assumption has been made and circulated that this action indicated a policy to restrict or to prevent free academic discussion. This belief is unwarranted. Indeed nothing could be further from the truth.

The trustees have not only always recognized fully the right of members of the teaching staff to hold and to give proper expression to individual views upon all questions, but there is not now and never will be the slightest wish on the part of the board or of a single one of the trustees to restrict the broadest latitude of opinions, research and discussion. When individual opinions of members of the teaching staff are expressed in a proper manner, upon proper occasions, and with proper respect for the dignity of their relationship to the university, and their consequent responsibility to the institution, such opinions and utterances are welcomed as indicative of progressive growth—no matter how divergent they may be from current or general beliefs.

It is not only not possible, but most undesirable, for any board of trustees to lay down definite

rules for guidance of members of any teaching staff. It would be a sad commentary upon the noble profession of teaching if any university should think a necessity existed to attempt to do so. If a teacher's own conception of the extent of his responsibility to young students, and his own realization of the importance given to his words by the mere fact that the university has commissioned and trusted him to teach, and has conferred upon him the right to use her name in addressing either students or the public, is not sufficient of itself to impose upon him discretion, dignity, fairness, truth, courtesy, sober-mindedness and consideration for differences of opinion, then manifestly any other form of restraint will be futile.

In order to discharge the duty laid upon the board by the charter, the trustees are required to observe and determine the qualifications of prospective teachers before appointing them as professors. The usual routine is an engagement as an instructor, an advance to an assistant professorship, followed—if justified—by appointment as professor. Dr. Nearing followed this usual course. He was found to have an attractive personality and many good qualities as a teacher. During the entire period of the few years in which he was connected with the university, however, his efforts—although doubtless perfectly sincere—were so constantly and continuously misunderstood by the public and by many parents of students, that much to the regret of the trustees they felt unable to give him the promotion to a professorship which he would otherwise have obtained. The termination of his temporary engagement was therefore absolutely in the line of the duty laid upon the trustees by the charter and in justice to Dr. Nearing himself, who was thus free to employ his talents in fields not circumscribed by either requests or promises to avoid strife and turmoil, which are neither necessary nor desirable accompaniments of the objects for which young men are sent to college by their parents.

When an individual teacher's methods, language and temperament provoke continued and widespread criticism alike from parents of students and from the general public who know him only by his public utterances, the freedom of choice in selection of some other person is a right equally as inherent in the board of trustees legally charged with its exercise by the charter, as is the right of freedom of opinion and thought, and teaching in the faculties. And this duty must be exercised for the good of the university as a whole.

The responsibilities of the governing body of any university as laid down in its charter are not confined to the care of its financial and material necessities. A selection or choice of an individual teacher is in itself no possible foundation for a just charge of restriction of academic freedom of speech, and is, of course, no indication whatever of a purpose to effect changes in the present teaching staff.

An expression of its views on this subject made by the board in a somewhat lighter vein some months ago—which it was hoped and supposed was all that would be necessary—is now reaffirmed. It is accordingly again inserted in the minutes, and in connection with this statement indicates the cordial feelings of friendship, admiration and respect felt by the trustees as a body and individually for the members of the faculties of the University of Pennsylvania, upon whose untiring and efficient labors the welfare of the institution depends.

Adopted by the board, 1913, and now reaffirmed:

"In all universities professors habitually express themselves freely upon questions which interest or divide the community. It could never seriously be suggested in any college or university in this country to stifle or control freedom of thought or expression by professors. In a large teaching staff of several hundred men, such as exists at the University of Pennsylvania, occasional unwise utterances are, of course, inevitable, but they do little harm.

"It is natural for some of the younger teachers to take themselves and their opinions upon current social or economic questions more seriously than is warranted by the extent of their practical experience. It is only the passage of years which leads discreet professors, as well as other workers in the world, to be tolerant of the opinions of other students of life as it exists.

"Infallible wisdom can not be expected to hover continuously over the chairs of all professors, any more than over all board rooms of trustees, or over all newspaper or any other offices. Differences of opinion must always exist. But if sanity and good temper and sober-mindedness are kept in view by all persons concerned—trustees, professors, students and public—there will seldom be any occasion for criticism, and none at all for an outcry on behalf of liberty of opinion and freedom of speech at the University of Pennsylvania."

SCIENTIFIC NOTES AND NEWS

As a memorial to the late Charles E. Bessey, the new biological laboratory, about to

be erected at the University of Nebraska, will be named Bessey Hall.

HENRI FABRE, the distinguished French entomologist and author, died on October 11 at Sérignan where he was born in 1823.

DR. RAY LYMAN WILBUR, professor of medicine, has been elected president of Leland Stanford Junior University. He will on January 1 succeed Dr. John Casper Branner who undertook to accept the presidency for a limited period on the retirement of Dr. David Starr Jordan, now chancellor of the university. Dr. Wilbur graduated from the academic department of Stanford University in 1896.

THE former students of Professor C.-E. A. Winslow have given a dinner in his honor on the occasion of his entrance into his new position of professor of public health at Yale University.

THE Rev. Dr. E. W. Barnes, fellow and tutor of Trinity College, Cambridge, has been appointed to the mastership of the Temple. He is the author of memoirs on Gamma functions, integral functions, linear difference equations and related mathematical subjects.

THE prize fellowship for original work published by women offered by the Federation of University Women has been awarded to Miss M. Wheldale, Newnham College, Cambridge.

DR. H. E. ROBERTSON, director of the department of pathology and bacteriology at the University of Minnesota, has declined an offer to become pathologist of the Murphy clinic of Chicago.

PROFESSOR FREDERIC E. CLEMENTS, of the University of Minnesota, and Mrs. Clements, spent the summer again in the west, carrying on further investigations into the relationship of climate and vegetation, for the Carnegie Institution of Washington.

PROFESSOR A. L. KROEBER, of the University of California, spent part of last summer among the Zuñi of New Mexico where he secured over nine hundred specimens illustrating their everyday and religious life. He made a detailed study of their system of relations and the terms employed to denote relationship.

A LECTURE on the subject of "Human Evolution in the Light of Recent Discoveries and its relation to Medicine," was delivered on October 13, by Dr. Ales Hrdlička, before a joint meeting of the Medical Society of the District of Columbia and the Anthropological Society of Washington.

A LECTURE on "The Production of Electricity by Living Organisms" was given by Professor Ulric Dahlgren before the Franklin Institute of Philadelphia on October 14.

PROFESSOR JAMES DRYDEN, head of the Oregon Agricultural College Poultry department, will address the meeting of the Poultry Breeders' Association, which will be held at the Panama-Pacific Exposition in November next. Professor Dryden's subject will be, "Selecting the Layers."

WE learn from *Nature* that Professor J. A. Fleming gave a public introductory lecture at University College, London, on "Science in the War and after the War," on October 6. Other public lectures are as follows: "Photographic Surveying," by Mr. M. T. M. Ormsby; "The History of Tools," by Professor W. M. Flinders Petrie; "Final Causes in Animal Psychology," by Mr. Carveth Read; "The Physiological Action of Light," by Professor W. M. Bayliss; "Steam Turbines," by Mr. W. J. Goudie; "Racial Frontiers in Central and Southeastern Europe," by Professor L. W. Lyde; "An Investigation of the Heating of the House of Commons," by Mr. A. H. Barker; and "The Applications of Electric Heating," by Professor J. A. Fleming.

MR. R. M. BARRINGTON, the Irish naturalist and ornithologist, died on September 15, at the age of sixty-six years.

DR. UGO SCHIFF, professor of chemistry at Florence, has died at the age of eighty-one years.

DR. CHARLES FREDERICK HOLDER, the naturalist and author, known for his books on marine zoology and related subjects, died at

his home in Pasadena, Cal., on October 11, aged sixty-four years.

Dr. A. Oppel, professor of anatomy at the University of Halle, has died, aged fifty-three years.

The winter meeting of the American Institute of Chemical Engineers will be held in Baltimore, Md., from January 12 to 15. The date selected is somewhat later than usual because the summer meeting was held late in August instead of in June, as is customary. Baltimore is the center of a considerable number of important chemical industries. Excursions to a number of these will be arranged. The experimental laboratories of the Johns Hopkins University and the Naval Academy at Annapolis, Md., will also be visited. A number of papers on recent and important developments in some of the chemical industries of the United States are being arranged for.

The program of the eleventh lecture course of the Harvey Society, to be given on Saturday evenings at the New York Academy of Medicine, is as follows:

October 16.—Professor C. W. Stiles, Hygienic Laboratory, Washington, D. C. "Recent Studies on School Children, with Special Reference to Hookworm Diseases and Sanitation."

November 6.—Professor A. J. Carlson, University of Chicago. "Recent Contributions to the Physiology of the Stomach."

November 27.—Dr. Eugene F. Du Bois, Cornell University. "The Respiration Calorimeter in Clinical Medicine."

December 18.—Professor Florence R. Sabin, Johns Hopkins University. "The Method of Growth of the Lymphatic System."

January 15.—Dr. Donald D. Van Slyke, The Rockefeller Institute for Medical Research. "The Present Significance of the Amino Acids in Physiology and Pathology."

February 5.—Dr. Hideyo Noguchi, The Rockefeller Institute for Medical Research. "Spirochetes."

February 26.—Professor Warfield T. Longcope, Columbia University. "The Susceptibility of Man to Foreign Proteins."

March 11.—Professor Henry A. Christian, Harvard University. "Some Phases of the Nephritic Problem."

March 25.—Dr. R. T. Woodyatt, University of Chicago. "A Conception of Diabetes."

April 8.—Professor Stanley R. Benedict, Cornell University. "Uric Acid in its relations to Metabolism."

April 29.—Professor William H. Welch, Johns Hopkins University. "Medical Education in the United States."

The following specimens have been stolen from one of the exhibits in the mines building of the Panama-Pacific International Exposition at San Francisco: Rough diamond, 4.39 carats; rough diamond, 0.72 carat; facetted black diamond, 17.99 carats; extremely hard diamond, rudely polished; gold specimen from Transylvania; gold nugget; platinum nugget. Any information leading to the recovery of these specimens may be communicated to Professor A. F. Rogers, Department of Geology, Stanford University, California.

It is stated in *Nature* that on September 23, a fire was discovered in the Technical School buildings, Market Street, Newton Abbot, and although the firemen succeeded in confining the outbreak to one room, much damage was done to the school museum, which included the life-long collection of the late Mr. W. Vicary, of The Priory, Exeter, bequeathed some years ago to his nephew, Mr. W. Vicary, chairman of the governors of the Technical School. The collection was considered to be one of the finest out of London, and many specimens were believed to be unique. It included thousands of specimens of minerals, some being very fine and rare. There were also some fine old flints from Dartmoor, stone implements, and a valuable collection of corals. Specimens from all parts of the world were included in the collection, and many can not be replaced. There was also an extensive collection of butterflies of numerous varieties, and some magnificent examples of sampler work, some dating from the sixteenth century. The massive cases, valued at about £300, were completely destroyed, and it is probable that the bulk of the collection is rendered useless by the great heat. Other things lost are the records of the school from 1868, the year of its

inception, and a collection of photographs, most of which can not be replaced, of people who have been connected with the school.

THE work of the San Juan Section of the Harvard Field School of Geology during the past summer included the systematic mapping of the southwest quarter of the Montrose quadrangle, the examination of several mines, and a two weeks' trip through the higher mountains of the range. There were fourteen students who were divided into seven teams. Each team of two men was assigned special areas for which the men were responsible, and the work of the several parties was compiled in an "office" on an office map. This was available for all to study, and thus see the larger problems which the study of the region brought out. Through this careful areal work a training in geologic mapping was obtained, and a foundation laid for an appreciation of the physical history of the San Juan Mountains. The expedition through the high mountains gave the men an opportunity to see and appreciate the remarkable physiographic features of the range, and to observe hundreds of field phenomena of geologic and physiographic significance. The work was carried on under the direction of Professor Wallace W. Atwood, and the party included the following men: Le Baron R. Briggs, Cambridge, Mass.; Norman Bradford, Jr., Newport, R. I.; Edward Condon, Shinnicock Hills, L. I.; John L. Ferguson, Spokane, Wash.; W. W. Kent, Chicago, Ill.; S. E. Peabody, Boston, Mass.; J. K. Selden, N. Andover, Mass.; T. L. Storer, Waltham, Mass.; Robert S. Sturgis, Winnetka, Ill.; W. J. R. Taylor, Rochester, N. Y.; L. Pierson Teas, Philadelphia, Pa.; Lucian B. Walker, Tulsa, Okla.; R. U. Whitney, North Haven, Maine; R. A. Terry, Chicago, Ill.

THE American Museum *Journal* states that a rare collection of archeological objects from the Department of Ica, Peru, was recently purchased by Mr. A. D. Juilliard and presented to the museum. This collection represents the results of numerous expeditions during the last nine years by Mr. Manuel Montero to the desert regions to the south and west of Ica. These visits to the prehistoric burial grounds were his vacations, and every object in the collection was excavated by him. The most notable objects are nine large shawl-like garments covered with conventionalized figures in embroidery. The beautiful color schemes seen in these textiles make them a joy to the artist, and they will doubtless be copied eagerly by the numerous art students who make constant use of the museum collections. Besides these shawl-like garments there are many smaller pieces of cloth which are highly ornamented. The metal work of these ancient people is represented by objects in silver and copper. There are several pairs of large silver ear-plugs, ornamented with embossed figures of birds, silver tweezers also ornamented with raised bird figures, and a number of shawl pins with finely executed figures of birds and pumas on the upper ends. The other objects in the collection consist principally of the women's workbaskets, with spindles and various colored threads, a loom with cloth in process of weaving, feather ornaments, slings, musical instruments and a few choice pieces of pottery.

UNIVERSITY AND EDUCATIONAL NEWS

THE Vassar jubilee endowment fund has reached $696,000, the gifts of the alumnæ amounting to $221,000.

THERE is a probability of a merger of the University of Pennsylvania medical school with that of the Medico-Chirurgical College of Philadelphia. If the amalgamation is consummated a great school for post-graduate medical work will be established at the University of Pennsylvania. The present students of the "Medico-Chi" would be transferred to the University Medical School, as well as a number of members of the faculty. Some of the "Medico-Chi" buildings together with large additions would become the headquarters for the postgraduate school.

THE work of grading the ground for the new medical school building of the University of Cincinnati directly opposite the Cincinnati General Hospital has begun. The school will

be ready for occupancy in about a year and a half. The cost of the buildings will be about half a million dollars.

The department of pharmacy of the Oregon Agricultural College has been notified of its acceptance as a member of the American Conference of Pharmaceutical Faculties.

The will of the late Mr. George May, mining engineer and colliery proprietor, of Darlington, bequeaths £500 to the North of England Institute of Mining Engineers, the income to be applied in providing "George May" prizes for students, and 500*l.* to Armstrong College, Newcastle, to found a "George May" scholarship in mining.

Professor Herbert Couper Wilson, of Carlton College, has been appointed visiting lecturer in astronomy, at Harvard University. Marshal Fabyan has been promoted to be assistant professor of comparative pathology.

DISCUSSION AND CORRESPONDENCE

PARASITES OF THE MUSKRAT

In a recent number of the *Journal of Parasitology*,[1] Professor Al. Mrázek, professor of zoology, Bohemian University, Prague, called the attention of American helminthologists to the opportunity for study of the parasites of one of the most typical North American mammals.

We announced in a recent number of Science[2] the finding of a varied and abundant parasitic fauna in muskrats in Nebraska and called attention to the important, virgin and fertile nature of this field for the parasitologist and the need and value of a thorough survey of the parasitic fauna of our common North American animals.

A study of the parasites of the muskrats, now practically completed, gives the following data. In forty-two muskrats, 881 parasites were found. No parasites were found in four muskrats, three harbored cestodes, trematodes and nematodes and three harbored a single species of trematode. The parasites found represent nine species of trematodes, of which three belong in the genus *Echinostomum* and one in each of the following genera, *Echinoparyphium, Notocotyle, Catatropis, Plagiorchis, Hemistomum,* and a new genus *Wardius.* Two species of cestodes were found belonging in the genera *Hymenolopis* and *Anomotaenia* and three species of nematodes, belonging in the genera *Trichiurus, Trichostrongylus* and *Capillaria.* The description of these parasites is given in the June number of the Journal of Parasitology, Vol. 1, No. 4.

Franklin D. Barker
The University of Nebraska

[1] 1914, Vol. No. 2, p. 104.
[2] 1913, Vol. 37, p. 268.

THE CHEMICAL COMPOSITION OF BORNITE

In Science for September 17, 1915, Professor Austin F. Rogers admirably summed up the evidence as to the composition of bornite, and concluded that the best explanation of the known facts is that the mineral consists of a solid solution of varying amounts of chalcocite, Cu_2S, in a normal bornite, Cu_3FeS_3. The object of this note is to bring forward another possible interpretation.

Since chalcocite is of common occurrence as inclusions in bornite the assumption that it may unite with the latter in solid solution is a reasonable one. But inclusions of chalcopyrite, $CuFeS_2$, and even of pyrite, FeS_2, are likewise frequently found, so it can not be denied that these minerals may also form solid solutions in the bornite. The clustering of analysis points in the diagram around Cu_5FeS_4 may then be accepted as "evidence that [normal] bornite has the formula Cu_5FeS_4" without excluding the possibility of solid solution, because the analyses lying in the diagram to the left of the Cu_5FeS_4 point may well be those which contain the chalcopyrite in solid solution, the absence of analyses far to the left of the Cu_5FeS_4 point indicating that this is the limit of solubility of chalcopyrite in bornite: $Cu_5FeS_4 + CuFeS_2 = 2Cu_3FeS_3$. The entrance of pyrite in solid solution would also account at least in part for those analyses lying above the diagonal line, and it need not be assumed that they are erroneous.

There is, however, another way of explaining variability in composition of the type shown

by bornite, which has perhaps not received the attention from mineralogists it deserves. Are we certain that the absence of inclusions of such size as to be visible under the microscope (in this case, the metallographic microscope) necessitates the hypothesis of the existence of solid solution at all? In metallographic study inclusions may be seen to vary more or less continuously from microscopically visible sizes down to the limit of microscopic visibility, which lies in the general neighborhood of 0.001 mm. in diameter. This lower limit is determined by the wave-length of light, and has no significance as far as chemical molecules are concerned. It can therefore not be expected that the variation in the size of inclusions ceases at that particular point; in all probability they also occur of submicroscopic size. Accordingly, as an alternative hypothesis to that of Professor Rogers the writer would suggest that the variability in the composition of bornite (normally Cu_5FeS_4) is due to the presence of submicroscopic inclusions of one or more of the minerals often occurring as visible inclusions in it, namely chalcocite, chalcopyrite and pyrite.

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WIND GAPS

ARE physiographers unconsciously predisposed in favor of an explanation of topographic phenomena which possesses a dramatic element as against one which, though quite obvious, involves only the operation of causes which are commonplace?

An examination of the explanation given of the formation of wind gaps by writers of American text-books on physical geography and geology would seem to answer this question in the affirmative.

All who treat this topic, so far as I have been able to determine, explain wind gaps—all of them—as deserted water gaps—vestigial structures, as it were, inherited from a certain stage in a past cycle of erosion.[1]

In this explanation all these writers hark back to the original source, the monograph by Bailey Willis on "The Northern Appalachians" (American Book Company, 1895). It is true that the monograph itself refers to earlier sources—to the work of Davis and Hayes and Campbell—but the constancy of reference by these text-book authors to Snickers Gap, cited in the monograph as a type illustration of a wind gap, and the reproduction of the two diagrammatic maps, there first printed as illustrations accompanying the explanation of same, indicate this monograph of Bailey Willis as the true source.

It is not the purpose of this article to detract from the general admirable treatment of mountain structure contained in the above treatise. It is one of the American physiographic classics, replete with that wealth of imagery derived from human activity which so characterizes a writer on physiography of the school of Davis. In that monograph streams now "leap" and now "loiter"; they "ripple over gravel bars" or "linger between alluvial banks"; they commit "piracy" and "conquer their neighbors."

It does seem to the writer, however, that a danger to scientific accuracy lurks in this imagery. An explanation that applies in the vast majority of instances is lost sight of because prosaic.

As a substitute, therefore, for the—beheading—diverting—reversing—stream processes, which must concur in the formation of every wind gap, it would seem, in the view of the writers of the above school of physiography, I would suggest the following:

A wind gap in the vast majority of instances is simply a col in the top of the divide, notched by the retreat of the sources of two

[1] Salisbury and Atwood, "Interpretation of Topographic Maps," p. 51. Salisbury, Atwood, and Barrows, "Text-book on Physiography." Tarr and Martin, "College Physiography," p. 567. Tarr, "New Physiography," p. 104. Hobbs, "Earth Features and Their Meaning," pp. 176, 177. Dryer, "Lessons in Physical Geography," p. 160. Emmerson, "Manual of Physical Geography." Trafton, "Laboratory and Field Exercises in Physical Geography," p. 19. Scott, "An Introduction to Geology," p. 448. Chamberlin and Salisbury, "Geology." Part I., p. 139.

streams which have happened to head opposite each other.

It is one of the commonest phenomena in a maturely dissected region, whether this be mountainous or simply a plateau.

In the Blue Ridge Region covered by Harpers Ferry sheet, there is nothing in the arrangement of the drainage or in the disposition of the contours which would suggest that all of those wind gaps—Snickers, Ashby, Crampton, Turners and a number unnamed—might not be as satisfactorily explained in this way as by a "diversion"—reversion—and "beheading" process. To my mind, the simple notching process affords by far the better explanation, since it fits in with the general and notable characteristic of the topography which militates against the Willis theory. This is the total lack of that "barbing" arrangement in the tributaries of the streams alleged to have been reversed which would seem to be necessary as conclusive evidence that these wind gaps are corollaries resulting from cases of "river piracy."

There is one line of evidence, namely, a progressive deepening of the wind gap notches in the Blue Ridge from the Water Gap of the Potomac at Harpers Ferry southward, which, if this were pronounced enough, might be alleged in support of the "River Capture Theory." However, Professor Willis barely hints at this evidence in calling attention to Manassas Gap—the most remote from the Potomac water gap of the wind gaps in the Blue Ridge south of the Potomac as well as the deepest.

The paragraphs from the Willis monograph which have become the sources of "the accepted text-book theory of wind gap formation" are as follows:

> On the Kittatinny Plain many smaller streams flowed across the ranges; and they also, persisting in their courses during the upheaval, cut water gaps in the hard beds. But they could not deepen the gaps as rapidly as did the great rivers, and the work of the smaller streams is now represented by the notches in the ridges high above the Shenandoah Plain. No streams now flow through these little V's: they are *wind gaps* from which a rivulet descends on each side of the ridge. . . . The Potomac traverses the Blue Ridge at Harpers Ferry. South of this water gap are several wind gaps, such as Snickers Gap, which mark the channels of ancient streams, now diverted. The Shenandoah River enters the Potomac above the water gap at Harpers Ferry, flowing northward along the western base of the Blue Ridge. The streams which passed through Snickers Gap and the other wind gaps ran above the present course of the Shenandoah, crossing it about at right angles. The two drainage systems could not exist at one time; therefore it is evident that the older one has been replaced by the younger river, the Shenandoah. This diversion took place by the gradual growth of the Shenandoah from its mouth southward. The Potomac, the large stream, cut its water gap faster than Snickers Gap was cut. The Young Shenandoah of the Kittatinny Plain, a small tributary of the Potomac where the mouth of the present Shenandoah is, acquired considerable fall as the Potomac deepened its gorge and sawed its channel down rapidly in the limestone, which offered no great resistance. But the stream in Snickers Gap, with perhaps less fall and not much greater volume than the Shenandoah, had to saw much harder rock in crossing the Blue Ridge. Its channel remained high, therefore, as compared with that of the Shenandoah. The latter, extending its headwaters backward as a tree puts out new twigs, eventually tapped the channel of the other stream above Snickers Gap. The waters above the point of attack joined the Shenandoah; the section between the point of attack and Snickers Gap was reversed as the Shenandoah rapidly deepened the channel of its new conquest; and the lower portion of the stream, now called Beaverdam Creek, having lost its original head waters, took its rise at Snickers Gap. Thus the ancient stream which once flowed through the gap was divided into three sections, the diverted, the inverted and the beheaded, while the Shenandoah, the diverter, was strengthened.

Thomas Jefferson, the only one of our presidents, except Roosevelt, who ever showed marked interest in science, also tried his hand at explaining topographic features of the Blue Ridge. It occurs in his notes on Virginia written in 1781, and the passage is as follows:

> The passage of the Potomac through the Blue Ridge is perhaps one of the most stupendous scenes in nature. You stand on a very high point of land. On your right comes up the Shenandoah,

having ranged along the foot of the mountain an hundred miles to seek a vent. On your left approaches the Potomac, in quest of a passage also. In the moment of their juncture they rush together against the mountain, rend it asunder and pass off to the sea.

The first glance of the scene hurries our senses into the opinion that the earth has been created in time, that mountains were formed first, that the rivers began to flow afterwards, that in this place particularly they have been dammed by the Blue Ridge Mountains, and have formed an ocean which filled the whole valley, that continuing to rise they have at length broken over at this spot and have torn the mountains down from the summit to the base.

Probably in the whole realm of literature there does not exist a more striking illustration of the cataclysmic point of view in attempting to explain geological phenomena than is expressed in the above passage, and it serves to illustrate how far in general in the scientific realm we have got away from the catastrophic ideas of Jefferson's day, which antedate even somewhat those of Cuvier and Schlotheim; yet when one examines the literature of modern physiography and sees the readiness with which "an uplifted and dissected peneplain" is invoked to explain every even sky-line or approximate uniformity in heights of mountain summits, while every peculiarity in drainage is accounted for as an inheritance from a past cycle of erosion, overlooking in many cases a simpler explanation involving only "processes now in operation"; he wonders if there does not lurk therein somewhat of the old catastrophism.

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SCIENTIFIC BOOKS

Der Nachweiss organischer Verbindungen. Augsgewählte Reaktionen und Verfahren. By DR. L. ROSENTHALER. Verlag von Ferdinand Enke, Stuttgart. 1914. 6 × 9.5 inches. Pp. xvii + 1,070. 35.20 Marks bound.

This work comprises the nineteenth and twentieth volumes of a series of monographs edited under the direction of Dr. B. M. Margosches, and published under the general title "Die Chemische Analyse. Sammlung von Einzeldarstellungen auf dem Gebiete der chemischen, technisch- chemischen, und physikalisch-chemischen Analyse." The earlier volumes are nearly all technical monographs dealing with the various phases of analytical chemistry. In the present volume, however, there has been gathered together an immense amount of general information for the organic chemist.

Everywhere that chemistry is taught there are given courses in inorganic qualitative analysis and text-books and reference works dealing with the separation and identification of inorganic compounds are to be found in every chemist's library. When, however, we pass into the realm of the carbon compounds we find that an entirely different situation obtains. There are but few texts or reference works dealing with the separation and identification of organic compounds, and it is a rare university that lists a course in qualitative organic analysis. This volume by Dr. Rosenthaler should, therefore, receive a hearty welcome from the organic chemist and will undoubtedly stimulate courses in the separation and identification of organic compounds.

In the introductory chapter are given the various qualitative tests for carbon, hydrogen, nitrogen, the halogens, sulfur, phosphorus, arsenic, etc., following which, in succeeding chapters are considered hydrocarbons, alcohols, aldehydes, ketones, carbohydrates, phenols, acids, oxy-acids, aldehyde- and keto-acids, ethers, quinones, esters, halogen derivatives, nitro derivatives, nitriles and iso-nitriles, acid amides, amines, aromatic hydrazines, azo and diazo compounds, acid derivatives of organic bases, heterocyclic bases, amino acids, polypeptides, organic sulphur compounds, organic arsenic compounds, alkaloids, resin acids, tannins, glucosides, saponines, pigments, proteins, enzymes and tox-albumens.

Rosenthaler's scheme of analysis is to first of all determine to which group or groups of compounds the unknown belongs. In order to do this the characteristic reactions of each class mentioned above are given very explicitly.

Then, following the class reactions, are the more common individual compounds, listing in each instance the physical and physiological properties of the compound, the methods for its preparation, the characteristics of its important compounds and derivatives, following which are methods for its identification, and in many instances methods for its separation from other compounds as well as its quantitative estimation. In all there are considerably over 2,500 organic compounds considered in greater or less detail.

The volume closes with a chapter on the preparation of the necessary reagents, followed by a table of melting points arranged in ascending order, this being in turn followed by a boiling point table similarly arranged. The arrangement of the index is decidedly novel. The index of compounds is in tabular form, giving the name of the compound, the page citation, the formula, the molecular weight and the percentage composition. The volume is concluded by an author index to the numerous literature citations.

Organic chemists have long felt the need of such a work, and it will, I am sure, find a hearty welcome. The identification of an organic compound should be relatively simple if this reference work is used as a supplement to Beilstein and Richter's "Lexikon." It is likewise admirably adapted for use as a text in a course of qualitative organic analysis.

Ross Aiken Gortner

Molecular Association. By W. E. S. Turner. London and New York: Longmans, Green and Co. 1915. Pp. viii + 170. Cloth. $1.40 net.

This is a further contribution to the series of monographs on inorganic and physical chemistry edited by Alexander Findlay. Dr. Turner, with the cooperation of a number of his students, has prepared a praiseworthy contribution to this excellent series of publications. In the nine chapters of the book are given an introduction and a discussion of molecular complexity in gases, dissolved substances, and the liquid state. Special attention is given to "the influence of the solvent" in the case of solutions, also to surface tension, and other methods of measuring molecular complexity of liquids, to the molecular complexity of water and the theory of dynamic allotropy. The selection and use of molecular formulæ, molecular association and physical properties, and molecular association and chemical combination are the subjects of the last three chapters. A long and fairly complete list of references to original literature is given at the end of the book. The appendix contains in tabular form a summary up-to-date of work done on the molecular complexity of dissolved substances. Here also references to original publications are added.

The author evidently regards the various molecular weight determinations in solutions as indicative of the actual molecular weights of the dissolved substances, and does not consider that the "abnormally" high or low molecular weights so frequently observed may quite as well be explained by a species of chemical union between solvent and dissolved substance. Thus it is not surprising that the entire subject of "molecular association and chemical combination" should have received only a step-motherly treatment, but five pages of the monograph being devoted to it.

The book is a compilation and not an original contribution. It will doubtless be useful to the advanced student of physical chemistry, who has thus brought before him in available and readable form the essence of the various important contributions on the subject treated. The author is clearly an enthusiast over the molecular theory, and the student can not but get some of this enthusiasm in perusing the monograph. May this result in further experimentation that shall bring to light more useful knowledge and a better conception of the act of solution as related to chemical combination, on the one hand, and the forces of cohesion and adhesion, on the other hand.

The book is printed on good paper, the typography is excellent, the cuts are well executed. but the binding is unattractive, cheap and not durable in form.

Louis Kahlenberg

SPECIAL ARTICLES

ON THE COEFFICIENT OF CORRELATION AS A MEASURE OF RELATIONSHIP

THE theory of correlation deals with the relationship between variable quantities in the case where that relationship lies somewhere between functional dependence and complete independence. In the case of normal correlation for two variables a certain quantity r, which is zero for complete independence and ± 1 for functional dependence, plays an important rôle. The formula for r, in terms of n observed pairs of values of two variables x and y, is

$$(1) \qquad r = \frac{\sum_{i=1}^{i=n} (x_i - x_0)(y_i - y_0)}{\sqrt{\sum_{i=1}^{i=n} (x_i - x_0)^2 \cdot \sum_{i=1}^{i=n} (y_i - y_0)^2}},$$

where x_0 is the mean of the x-values and y_0 the mean of the y-values.[1] This formula has also been given an interpretation for the case of skew correlation[2] which makes r an important quantity in many instances of such correlation.

The quantity r is usually termed the coefficient of correlation and is said to measure the amount of correlation between the variables x and y. This latter statement is too vague as it stands for scientific procedure, so it is desirable to state more precisely what is meant by it. In the case of normal correlation r has been shown to have the following significance:[3] if we take the mean of all the y's corresponding to a given value of x, then the deviation of this mean from the mean of *all* the y's, divided by the standard deviation of the y's, is equal to r times the deviation of the given x-value from the mean of all the x's, divided by the standard deviation of the x's. Thus r may be said to measure the tendency of a given deviation from the mean in one of the variables to be associated with an average deviation from the mean of corresponding magnitude in the other variable.

It is clear that the value of r throws much light on the relationship between two variable quantities in the case of normal correlation. It is not apparent, however, that it gives us in every instance the information we are most interested in obtaining, and it will be shown in what follows, that in certain cases of interest in the applications of the theory of correlation it will not necessarily give it.

The formula (1) is well adapted to the computation of r from observed values of x and y. For our purposes, however, we need a formula which exhibits r as a function of the underlying variable quantities that determine x and y and the relationship between them. We shall now proceed to obtain such a formula on the basis of assumptions similar to those that Pearson used in his derivation of (1).[4]

Let

$$(2) \qquad \begin{aligned} x &= f_1(\epsilon_1, \epsilon_2, \cdots, \epsilon_m), \\ y &= f_2(\epsilon_1, \epsilon_2, \cdots, \epsilon_m), \end{aligned}$$

where the ϵ's are independent variables that follow a Gaussian distribution, and the f's are analytic functions. If we expand the right-hand members of (2) about the mean values of the ϵ's and neglect higher powers than the first,[5] we have

$$(3) \qquad \begin{aligned} x - x_0 &= a_{11}\eta_1 + a_{12}\eta_2 + \cdots + a_{1m}\eta_m, \\ y - y_0 &= a_{21}\eta_1 + a_{22}\eta_2 + \cdots + a_{2m}\eta_m, \end{aligned}$$

where the η's are deviations of the ϵ's from their mean values and x_0 and y_0 are mean values of x and y, respectively.

Since the ϵ's are independent variables following a Gaussian distribution, we have

[1] *Cf.* Pearson, "Regression, Heredity and Panmixia," *Philosophical Transactions of the Royal Society*, 187 *A* (1896); also Bravais, "Analyse mathématique sur les probabilités des erreurs de situation d'un point," Académie des Sciences: Mémoires présentés par divers savants, Ser. 2, Vol. 9 (1846).

[2] *Cf.* Yule, "On the Significance of Bravais's Formulæ for Regression, etc., in the Case of Skew Correlation," *Proceedings of the Royal Society*, Vol. 60 (1897).

[3] *Cf.* Pearson, *l. c.*

[4] *L. c.*

[5] Pearson assumes that the variations of the ϵ's from their mean values are small in comparison with those values, in order to justify the dropping of higher powers. It is more general to assume merely that for the range of values of the ϵ's considered, the f's are sufficiently good approximations to linear functions to warrant the neglect of higher powers.

$$\sum_{v=1}^{v=n} \eta_i^{(v)} \eta_j^{(v)} = 0 \qquad (i \neq j),$$

where

$$(\eta_i', \eta_j'), (\eta_i'', \eta_j''), \cdots, (\eta_i^{(n)}, \eta_j^{(n)})$$

are n pairs of values of η_i and η_j. Hence, substituting in (1) the values of $(x - x_0)$ and $(y - y_0)$ given by (3), we obtain

$$(4) \qquad r = \frac{\sum_{i=1}^{i=m} a_{1i} a_{2i} s_i^2}{\sqrt{\sum_{i=1}^{i=m} a_{1i}^2 s_i^2 \cdot \sum_{i=1}^{i=m} a_{2i}^2 s_i^2}},$$

where the s's are the standard deviations of the ϵ's. The formula (4) for r is well adapted to the discussion of the connection between the value of r and the relationship between x and y. We shall use it first to show that under certain conditions r will not furnish a satisfactory measure of the particular form of relationship in which we are interested.

Consider, for example, the use of correlation in educational investigations. A value for r is computed from the performances of a group of persons in two fields of mental activity, such as two school subjects, and the closeness of relationship between the two fields or subjects is discussed on the basis of this value. It is clear that the value of r is a good measure of the tendency of the members of the group having a given deviation from the mean ability of the whole group in one field, to have an average deviation of corresponding magnitude from the mean ability of the whole group in the other field. It is certainly useful to be able to measure such a tendency, but there is something else which it is more useful from the educational standpoint to be able to measure. Suppose the average ability of the whole group in one field is increased a certain amount by training in that field, and this in turn causes a certain increase in the average ability of the whole group in the other field. The ratio of this latter increase to the former, when each is measured in terms of the standard deviation of the group in the corresponding field, is a very important quantity in educational investigations; it is vital for example in the discussion of such questions as disciplinary values.

We will now proceed to show that under certain conditions this ratio may be much greater than r. Since ability in any complicated field of mental activity like a school subject may be regarded as a function of a great many elementary abilities, the abilities x and y in two subjects may be represented as in equation (2). If we expand about the mean values of the ϵ's at any given time and neglect higher powers than the first,[6] we get equations of the type (3).

Since ability in each of the two subjects will in general depend on certain elementary abilities not involved in the other, we shall consider a case where certain of the a's in the first equation in (3) are zero and certain of the a's in the second equation are zero. Let us suppose then that

$$(5) \qquad \begin{aligned} a_{11} = a_{12} = \cdots = a_{1p} &= 0, \\ a_{2,\,m-p+1} = a_{2,\,m-p+2} = \cdots = a_{2m} &= 0, \end{aligned}$$

and let us suppose further that

$$(6) \qquad \begin{cases} a_{j,\,p+1} = a_{j,\,p+2} = \cdots = a_{j,\,m-p} = a > 0 \\ \qquad\qquad\qquad\qquad\qquad\qquad (j = 1, 2), \\ a_{1,\,m-p+1} = a_{1,\,m-p+2} = \cdots = a_{1m} = 100a, \\ a_{21} = a_{22} = \cdots = a_{2p} = 100a, \\ s_1 = s_2 = \cdots = s_p = s, \\ m = 902p. \end{cases}$$

If by training in one subject the average ability of a group of persons in that subject is increased a certain amount, it is reasonable to suppose that this increase has been uniformly distributed in the way of corresponding increases in each of the elementary abilities involved in that subject. Since from (6) the standard deviations of the elementary abilities are all equal in the present case, a uniform distribution of the increase would imply an equal increase in each elementary ability. We will assume then that after training in the subject, the mean value of each ϵ of which x is a function is increased by a quantity δ. Since the η's occurring on the right-hand side of the first equation in (3) are deviations from the original means of the ϵ's, the mean value of each of them will now be δ instead of zero.

[6] In the present instance we neglect higher powers on the assumption that ability in the given subject is approximately a weighted mean of the elementary abilities on which it depends.

Hence, in view of (5) and (6), the mean value of x will be

$$x_0' = x_0 + 1{,}000\ p\ a\ \delta. \tag{7}$$

Similarly the mean value of y after the increase in the average value of the ϵ's involved in x, the ϵ's involved in y but not in x remaining constant, will be

$$y_0' = y_0 + 900\ p\ a\ \delta. \tag{8}$$

Therefore, since the standard deviations of x and y, s_x and s_y, are equal,

$$\frac{y_0' - y_0}{s_y} \Big/ \frac{x_0' - x_0}{s_x} = 0.9. \tag{9}$$

It is apparent from (9) that in this instance a certain increase in the average ability x will be accompanied by an increase almost as great in the average ability y.

If r is to be considered in all cases a reliable measure of the closeness of relationship between two fields of mental activity, it ought to be approximately equal to the ratio in (9). Let us see what its value actually is. Making use of equations (4), (5) and (6), we get

$$r = \frac{900pa^2}{\sqrt{(900pa^2+10{,}000pa^2)\,(10{,}000pa^2+900pa^2)}} = 0.08 \text{ approximately.} \tag{10}$$

We have dealt here with a special case, but it is easy to see from the above discussion that in many other cases we would have discrepancies of the same sort. Hence it is apparent that it is not safe to assume off-hand that r is always the best measure of the relationship between two fields of mental activity. It may be a very poor measure of the form of relationship in which we are interested.[7]

The question naturally arises, under what conditions will r be a good approximation to the value of the ratio in (9)? It is the purpose of the rest of this paper to obtain certain sufficient conditions that this will be the case. It is very easy to see that if all the a's of equation (3) which are not zero are equal to each other in absolute value, and furthermore if the standard deviations of the ϵ's are all equal to each other, r will be exactly equal to the ratio in (9). This leads one to suspect that if these conditions are fulfilled to a sufficient degree of approximation, r will not differ very much from this ratio.

In discussing the general case there are really two ratios of the type (9) to be considered, according as the training has been in the field corresponding to x or in the field corresponding to y. In the special case discussed above these two ratios were identical, so we only considered one of them. Under the hypotheses we shall make in what follows, the discussion for one ratio is practically the same as the discussion for the other, so here too we shall only consider one of them.

We will investigate first the case where all the a's on the right-hand side of the equations in (3) are positive or zero. It is apparent that there is no loss of generality in supposing that the a's which are zero in the first equation are the a's of the first p terms and the a's which are zero in the second equation are the a's of the last q terms. In particular p, or q, or both of them, might be zero.

Since the standard deviations of the ϵ's involved in x are no longer necessarily equal to each other, a uniform distribution over these ϵ's of an increase in x would result in an increase in each ϵ proportional to its standard deviation. Let us suppose then that after training in the field corresponding to x the mean value of each ϵ_v involved in x has been increased by an amount $s_v\delta$. Representing as before by x_0' the mean value of x after the increase in the ϵ's we have

$$x_0' - x_0 = \sum_{v=p+1}^{v=m} a_{1v}s_v\delta. \tag{11}$$

Similarly, if y_0' represents the mean value of y after the increase in the ϵ's, we have

$$y_0' - y_0 = \sum_{v=p+1}^{v=m-q} a_{2v}s_v\delta. \tag{12}$$

[7] We have restricted ourselves in the foregoing discussion to the case of relationship between different fields of mental activity. The mathematical part of the discussion, however, will undoubtedly have a bearing on many applications of the theory of correlation. If for any two variables x and y, the a's of equation (3) satisfy the conditions of our special case, the ratio of the common factors involved in the variation of x and y to all the factors, will, for each variable, be 0.9. Hence r, which is given by (10), will not be a good measure of the closeness of relationship between the two variable quantities.

Hence we have

$$R = \frac{y_0' - y_0}{s_y} \Big/ \frac{x_0' - x_0}{s_x}$$

$$= \frac{\sum_{v=p+1}^{v=m-q} a_{2v}s_v}{\sum_{v=p+1}^{v=m} a_{1v}s_v} \cdot \frac{\sqrt{\sum_{v=p+1}^{v=m} a_{1v}^2 s_v^2}}{\sqrt{\sum_{v=1}^{v=m-q} a_{2v}^2 s_v^2}}. \tag{13}$$

Let us now suppose that two positive quantities a and s, and a positive quantity $\rho < 1$, exist, such that

$$\begin{aligned} &a(1-\rho) \leqq a_{1i} \leqq a(1+\rho) \quad (i = p+1, p+2, \cdots, m), \\ &a(1-\rho) \leqq a_{2i} \leqq a(1+\rho) \quad (i = 1, 2, \cdots, m-q), \\ &s(1-\rho) \leqq s_i \leqq s(1+\rho) \quad (i = 1, 2, \cdots, m). \end{aligned} \tag{14}$$

It follows readily from (13) and (14) that

$$\left(\frac{1-\rho}{1+\rho}\right)^4 \frac{m-p-q}{\sqrt{(m-p)(m-q)}} < R < \left(\frac{1+\rho}{1-\rho}\right)^4 \frac{m-p-q}{\sqrt{(m-p)(m-q)}}. \tag{15}$$

Similarly from (4) and (14) we have

$$\left(\frac{1-\rho}{1+\rho}\right)^4 \frac{m-p-q}{\sqrt{(m-p)(m-q)}} < r < \left(\frac{1+\rho}{1-\rho}\right)^4 \frac{m-p-q}{\sqrt{(m-p)(m-q)}}. \tag{16}$$

We might obtain still narrower limits for the values of R and r than those given in (15) and (16). It is apparent from the limits obtained, however, that if ρ is sufficiently small, r will furnish a good approximation to the value of R.

We will now consider the case where some of the a's on the right-hand side of the equations in (3) are negative. Let us suppose that the first λ of the $(m-p-q)$ η's that appear in both equations have coefficients of the same sign in the two equations, and that the remainder, μ in number, have coefficients of opposite signs. Obviously, an increase in x that is uniformly distributed with regard to the ϵ's involved in x, will be accompanied by a decrease in those ϵ's for which the corresponding η's have negative coefficients in the first equation in (3); also an increase in an η having a negative coefficient in the second equation will cause a corresponding decrease in the value of y. Hence we have for the ratio in (9)

$$R = \frac{\frac{y_0' - y_0}{s_y}}{\frac{x_0' - x_0}{s_x}} = \frac{\sum_{v=p+1}^{v=p+\lambda} |a_{2v}| s_v - \sum_{v=p+\lambda+1}^{v=m-q} |a_{2v}| s_v}{\sum_{v=p+1}^{v=m} |a_{1v}| s_v} \cdot \frac{\sqrt{\sum_{v=p+1}^{v=m} a_{1v}^2 s_v^2}}{\sqrt{\sum_{v=1}^{v=m-q} a_{2v}^2 s_v}}. \tag{17}$$

Let us now suppose that the a's and the s's satisfy equations of the type (14), *i. e.*, equations obtained by replacing the a's in those equations by their absolute values. Then it is easy to see that if $\lambda > \mu$, and ρ is sufficiently small,

$$\begin{aligned} &\frac{\lambda-\mu}{\sqrt{(m-p)(m-q)}} \cdot \frac{(1+\rho^2)(1-\rho)^2}{(1+\rho)^4} - \frac{2(\lambda+\mu)}{\sqrt{(m-p)(m-q)}} \cdot \frac{\rho(1-\rho)^2}{(1+\rho)^4} < R \\ &< \frac{\lambda-\mu}{\sqrt{(m-p)(m-q)}} \cdot \frac{(1+\rho^2)(1+\rho)^2}{(1-\rho)^4} + \frac{2(\lambda+\mu)}{\sqrt{(m-p)(m-q)}} \cdot \frac{\rho(1+\rho^2)}{(1-\rho)^4}. \end{aligned} \tag{18}$$

Furthermore, in view of (4), we have for r

$$\begin{aligned} &\frac{\lambda-\mu}{\sqrt{(m-p)(m-q)}} \cdot \frac{1+6\rho^2+\rho^4}{(1+\rho)^4} - \frac{4(\lambda+\mu)}{\sqrt{(m-p)(m-q)}} \cdot \frac{\rho(1+\rho^2)}{(1+\rho)^4} < r \\ &< \frac{\lambda-\mu}{\sqrt{(m-p)(m-q)}} \cdot \frac{1+6\rho^2+\rho^4}{(1-\rho)^4} + \frac{4(\lambda+\mu)}{\sqrt{(m-p)(m-q)}} \cdot \frac{\rho(1+\rho^2)}{(1-\rho)^4}. \end{aligned} \tag{19}$$

The corresponding inequalities for the cases where $\lambda \leqq \mu$ are easily obtained. It follows from (18) and (19) or the corresponding inequalities, that r will be a good approximation to R if ρ is sufficiently small.

The case where all the a's on the right-hand side of (3) that are not zero, are negative, does not seem to have any great interest in connection with the applications discussed in this paper. In any event the treatment of that case presents no new difficulties, so we shall not consider it here.

This paper makes no pretense of being an exhaustive treatment of the subject under consideration. Its main object has been to point out as briefly as possible the danger of assuming that the coefficient of correlation is necessarily a satisfactory measure of all forms of relationship between two variable quantities, and at the same time to suggest a method of attack for determining in what way a particular relationship depends on the value of this coefficient.

CHARLES N. MOORE
UNIVERSITY OF CINCINNATI

AN ABERRANT ECOLOGICAL FORM OF UNIO COMPLANATUS DILLWYN

THE variety of *Unio complanatus* Dillw. which is here described was found at Songo Pond, about three miles south of Bethel, Me. The specimens from which it is described were collected in August, 1913. The pond is a headwater of the Crooked River, one of the larger tributaries of the Presumpscot. It lies in a glacial scoop in alluvial sand, and is fed by springs mainly. A small brook a mile long enters it also. The country rock is a granitic gneiss of the eastern range of Montalban gneisses, and the intrusive granites scattered here and there are of the same mineralogy. There is no limy rock in any form within many miles, a fact which will account for the peculiar structure of the shell. The specimens were picked up on a very gently sloping beach of round-grained sand, along the western shore of the pond, and in about two feet of water. The pond is about a mile and a quarter long, from north to south, and averages a quarter of a mile in width.

So far as I can determine, the soft parts of the animal are in every way normal for the species. The aberrancy occurs in the valves, and is in structure and in shape.

The largest of my specimens, and the largest I have seen in the course of eight summers' picking, measures two and three quarters by one and a half inches over all. The greatest thickness, from umbo to umbo, is three quarters of an inch. The following features are normal: hinge size and place, umbo size, place and shape, lateral and pseudocardinal teeth size and shape, scars, pallial line, and sculpture. Epidermis is of normal color, but thicker than usual, and overlaps the edge of the hard part of the shell up to 3/32 of an inch, being most extended at the siphonal region and along the anterior part of the ventral edge in many specimens.

The shape of the shell is almost identical with that of *Anodonta marginata* Say, being roughly rhomboidal. It does not resemble the specimens of *Unio complanatus* from other regions in the American Museum at New York, in this respect. From the posterior end of the hinge, the dorsal edge slopes ventrally, straight, at an angle between 35 and 40 degrees from the line of the hinge. This portion of the edge is nearly straight and about as long as the hinge. It rounds off into the small semicircle of the posterior end. In mature specimens there may be a slight flattening of the posterior end at the point where the mantle forms a pair of siphons by its folding and coherence, but this is not constant and I find it only in the largest specimens. The ventral edge is not a uniform curve, but approaches more or less to three straight lines, equal in length, each making an angle of about ten degrees with the line continuing the edge beyond it. The anterior end has the usual graceful elliptical outline, forming a large curve from hinge to ventral edge.

There are no rays visible on any of my specimens.

The most peculiar feature of the shell is the exceedingly small amount of mineral matter in it. When fresh the shells are horny and somewhat flexible, not unlike two layers of parchment pasted together, in texture. Alcoholic material and fresh are alike easily cut with a small shears, and there is no cracking. The thin nacreous layer breaks into small angular chunks, which adhere to the epidermis. I found only the faintest traces of a prismatic layer, in the largest specimens. Smaller ones fail entirely to show it. In my largest specimens there is at the umbo a larger amount of mineral matter, but even here it is hardly more in amount than at the margin in the normal shell of this species. The epidermis seems to me to be nearly twice as thick as in the normal type. In many specimens I found grains of

sand imbedded in the outer part of the epidermis, and apparently thoroughly encased.

This feature is quite obviously the result of the nature of the water in which the shells grew. There is no lime to be had save what little weathers out of the felspar of the country rocks: as these are largely soda felspars, this amount is indeed small.

If this be a variety worthy of a name, I would suggest that it be called *Unio complanatus* var. *mainensis*. It seems to be a form native to the granitic region of New England, and so far as I know is found mainly in western Maine. It is common throughout the ponds and lakes of Oxford county in that state. Since 1909 it has become so plentiful in Songo Pond that one can pick up ten dozen in half a hour, within three hundred feet along the beach. I have been in the habit of gathering it to boil for eating: it is quite palatable if cooked just the right time and with much salt.

My thanks are due to Dr. L. P. Gratacap, of the American Museum of Natural History, for aid in determining the shells, and to Professor F. Loomis, of Amherst College, for suggesting that the variety might be of general interest.

Stephen G. Rich
Ithaca, N. Y.

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

A special meeting of the American Phytopathological Society and its Pacific Division, was held at the University of California, from August 3 to 5. Addresses of welcome were delivered by Dr. Herbert J. Webber, director of the Citrus Experiment Station and Dean of the Graduate School of Tropical Agriculture, Riverside, California, and Professor R. E. Smith, president of the Pacific Division of the society.

Dr. Haven Metcalf responded for the society.

The following program was presented:

International Phytopathology: Otto Appel, Dahlem, near Berlin, Germany. (Read by Dr. C. L. Shear. This will be published in full in *Phytopathology*.)

Pythiacystis Infection of Deciduous Nursery Stock: E. H. Smith, University of California, Berkeley, Calif.

A dieback of young deciduous trees, which occurred extensively in northern California the past two seasons, has been traced to a species of *Pythiacystis*, morphologically identical with *P. citrophthora*. Most of the root stock is apparently immune, but above the bud the bark is infected in one to several cankers, which often girdle the tree and kill back the whole top. Profuse gumming occurs. The fungus has been isolated from peach, almond, pear and plum, and the disease produced by inoculation in apple, pear, peach, almond, apricot, prune and cherry, all from one-year-old stock. Similar cankers have been produced by inoculation with *P. citrophthora* isolated from lemon fruit. A pythiaceous fungus has been twice isolated from almond cankers and successfully inoculated into almond, which readily develops an oospore stage. This has different characters of growth from the original strain, and a less degree of pathogenicity, but may ultimately be placed in the same species.

Two Eastern Forest Diseases which Threaten the Pacific States: Haven Metcalf, U. S. D. A., Washington, D. C. (with lantern).

The speaker exhibited lantern slides and specimens of the chestnut-bark disease (*Endothia parasitica*) and the white-pine blister rust (*Cronartium ribicola*). The danger which these diseases present to the cultivated chestnut of the Pacific states and to the native stand of five-leaf pines was indicated. Especially to be considered is the danger to the very valuable species *Pinus lambertiana* and *P. monticola*. The speaker advocated rigid state quarantines against nursery stock of the genus *Castania*, the 5-leaf species of pines, and the genus *Ribes*.

Beet Blight: R. E. Smith, University of California, Berkeley, Calif.

Specimens of diseased beets were exhibited and the methods being employed in the study of the disease were explained and illustrated. The structure of the diseased beets was dis-

cussed and certain peculiarities were described. Possible connection with certain bacteria was suggested and the nature and difficulties of the problem concerned were discussed. In the discussion which followed the paper Director Ball, of Utah, and a number of others gave their views on certain phases of the problem, especially with regard to the relation of the disease to insects. Mr. August Boncquet, of Spreckels, California, gave support to the suggestion that only insects which have been in contact with diseased beets are capable of transmitting the disease.

Forest Pathology: E. P. MEINECKE, U. S. D. A., San Francisco.

A number of forest diseases were exhibited, including interesting and important rusts and mistletoes. Several new hosts were shown in the collection, and important but hitherto not well-known forms were included in the demonstration.

Northwestern Apple Anthracnose: H. S. JACKSON, Corvallis, Oregon.

Specimens were shown of the disease in various forms, and the technical phases, particularly culture work and cross inoculations with the different spore forms, were discussed and the economic status of the disease briefly indicated.

The second session was held in the laboratory of plant pathology Thursday morning, August 5, at 9:30.

Apple Mildew: W. S. BALLARD, U. S. D. A., Watsonville, Calif.

The nature of this disease was explained briefly, and an account of the history of the efforts which have been made to discover effective control measures was given. Use of colloidal sulphur, prepared by dissolving sulphur in melted resin, grinding and putting into ammonia water, was described. The difficulties involved in the use of sulphur in the California coast districts on account of the danger of injury to the trees were discussed and the reasons for the use of unusually dilute spray formulas were mentioned.

Mottled Leaf of Citrus Species: J. T. BARRETT, Riverside, Calif.

Professor Barrett reviewed the main features of this disease and showed typical specimens. No specific cause has been discovered and the disease is still classed as a non-parasitic disease. The diseased leaves contain more starch than normally on account of defective translocation, and apparently also an excess of nitrogen. Some relation appears to have been discovered between fertilization with nitrate of soda without the addition of vegetable material and mottled leaf, but it was pointed out that this is probably not a direct effect of the materials used, but of the soil condition produced, since in plots in which liberal use had been made of the vegetable material the disease has not appeared. The disease is being studied at Riverside from all possible points of view and is being treated as a station problem and not exclusively by any one department. The possibility of an infectious chlorosis is also being investigated. In the discussion Professor F. S. Earle pointed out that there are probably two distinct types of mottled leaf in Cuba and the Isle of Pines, arising from what is probably a specific disease of the small roots and from general unfavorable soil conditions.

Bacterial Canker of Cherry and Filbert Disease: H. P. BARSS, Corvallis, Oregon.

Griffin showed the bacterial origin of the bud blight in cherries. The identity of cause for bud blight and body canker was shown by the speaker by means of inoculations made in the fall. Inoculations at other seasons were not successful. The disease is most destructive during the first seven or eight years of the life of the tree. It is now largely controlled by planting Mazard apricot, prune and Simone plum.

The filbert disease is also caused by bacteria, being in this case a yellow organism similar to the walnut blight bacterium. A leaf spotting and killing of twigs are produced and cankers are formed, succulent tissue being susceptible.

Crown Rot of Fruit Trees: Histological Studies: J. G. GROSSENBACHER, U. S. D. A., Washington, D. C. (Read by title.)

Some New and Old Methods in Plant Pathology: J. Franklin Collins, U. S. D. A., Washington, D. C. (Read by title.)

Citrus Gummosis and Melaxuma: H. S. Fawcett, Whittier, Cal.

These diseases were illustrated by means of lantern slides and brief explanations, together with a set of specimens and photographic enlargements in the laboratory. The former is caused by the fungus *Pythiacystis citrophthora* S. and S., and the latter by a fungus which is probably a *Dothiorella.*

Fruit Stain and Wither Tip of Citrus: J. T. Barrett, Riverside, Cal.

Effects of the fungus *Colletotrichum gloeosporioides* were illustrated on twigs and fruit. Dr. Barrett stated that he did not yet have evidence that the fungus is capable of infecting thoroughly sound and healthy tissue of leaves and twigs, but infection of the fruit through germination from appressoria, killing small areas of rind, and later development of the fungus cause serious fruit rotting in addition to the tear-stain marks upon the surface.

Observations on Prune Rust (Puccinia Prunispinosæ Pers.) in Southern California: J. T. Barrett, Riverside, Cal.

This fungus has become serious at times in southern California on apricots and peaches. The characteristic spots and injury to the orchard by defoliation were shown by lantern slides. In some cases early fall pruning has stimulated fall growth in which foliage remains alive through the winter and rust developed in this has caused early spring infection with very detrimental effects to the orchards.

Coryneum Fruit Spot of Apricots: J. T. Barrett, Riverside, Cal.

Characteristic spotting was illustrated by lantern slides. This disease is not of so wide distribution in apricots as has been supposed. Accordingly, spraying operations carried out for this trouble have not given satisfaction in all cases.

Walnut Blight and Crown Gall: C. O. Smith, Whittier, Cal.

The symptoms of this disease were illustrated by means of lantern slides and specimens were shown in the laboratory.

August 5, 2 P.M. The program was continued in the laboratory of plant pathology.

Peridermium Harknessii Moore, and Cronartium Quercuum (Berk.): E. P. Meinecke, U. S. D. A., San Francisco, Cal.

The results of extensive observations on these rusts and inoculation experiments with the different spore forms were given.

An Established Asiatic Gymnosporangium in Oregon: H. S. Jackson, Corvallis, Oregon.

Results of careful studies and cross inoculations with a newly imported *Gymnosporangium* discovered on Oriental pears in Oregon were given.

The Need of a Pure Culture Supply Laboratory for Plant Pathology in America: C. L. Shear, U. S. D. A., Washington, D. C. (To be published in full in the October number of *Phytopathology.*)

Studies of the Rhizoctonia Disease of Potatoes: J. H. Corsaut, Corvallis, Oregon.

On account of the seriousness of potato troubles due to *Rhizoctonia* in the state of Oregon, studies on this disease were undertaken. Affected plants and tubers were secured from different localities and a large number of different strains of the causal organism were isolated from sclerotia on the tubers, from sterile mycelium on the underground parts of the plant, from basidium-bearing mycelium, and from individual basidiospores. The cultural characters of these strains were similar, but showed some variation. A splendid development of the typical *Corticium* (*Hypochnus*) stage appeared on the stems of young plants grown in sterilized soils from sterilized seed pieces which had been inoculated with pure culture of the organisms isolated from sclerotia, sterile mycelium, and single basidiospores. A number of different varieties of potatoes were inoculated with *Rhizoctonia* grown under similar conditions and the effects noted. Some varieties proved extremely susceptible, while others were rather strongly resistant. It was also found that when grown on sterile raw plugs cut from different varieties of potatoes the fungus developed rapidly on certain varieties and but slowly on others. By artificial

means healthy *Rhizoctonia*-free potato plants were made to reproduce both the "aerial potato" condition and the "little potato" condition, which are frequent consequences of natural attacks of *Rhizoctonia*. These experiments indicate that the abnormal effects referred to are purely secondary results of the *Rhizoctonia* attack caused by interference with the normal process of food storage in the plant.

Studies of Monilia Blight of Fruit Trees: G. B. POSEY, Corvallis, Oregon.

From blighted twigs of apricot, prune and pear there was isolated by different members of the staff of the department of botany and plant pathology of the Oregon Agricultural College during the season of 1913 a species of *Monilia*, apparently unlike, in cultural characters, the common "brown rot" fungus of the stone fruits (*Sclerotinia cinerea* Bon.), which is abundant in Oregon. An investigation of this blight-producing *Monilia* was undertaken. Over fifty strains were isolated and a comparison made with over fifty strains of *Sclerotinia cinerea* from Oregon and other parts of this country and with four strains of *Sclerotinia fructigena* secured from England. Culture studies on a great variety of artificial media, inoculations into various kinds of fruits, and inoculations upon the twigs of various kinds of fruit trees proved that this apparently unrecognized species of *Monilia* is entirely distinct from the strains of *S. cinerea* and *S. fructigena* used for comparison.

The investigation thus far has shown that this *Monilia* is apparently common in the Pacific Northwest. It has been found on blighted blossoms, spurs and twigs, and sometimes on mummied fruits of pear, quince, apricot, peach, prune, plum and cherry. It usually starts in the spring as a blossom blight and works back into the spurs and branches, where the progress of the fungus is checked as the season advances. Tender shoots are sometimes attacked. Sporodochia are formed on the affected parts during the same season and spores are produced until late in the following spring. No ascosporic stage of the *Monilia* under discussion has as yet been found, although apothecia of the common *S. cinerea* were collected abundantly on mummied fruits of apple, pear, prune, plum, peach, apricot and cherry. The investigation will be continued.

A Podosporiella Disease of Germinating Wheat: P. J. O'GARA, Salt Lake City, Utah.

On examining a weak strain of wheat in Salt Lake Valley the trouble was traced back to the seed, the content of the kernels of which were found to have been largely consumed by a dark brown, septate mycelium, which did not appear on the surface. The seed coat was penetrated later by the fruiting stalks of the fungus, which was found to be a new species of *Podosporiella*. The fungus is not considered to be a true parasite, since it does not attack the kernel till about the time of germination, and has never been found in the growing portions of the plant. The disease is found to be most prevalent in volunteer wheat, and where several crops had been grown with only surface cultivation.

The Utilization of Certain Pentoses and Compounds of Pentoses by Glomerella cingulata (Stonem.) S. and v. S.: L. A. HAWKINS, U. S. D. A., Washington, D. C.

In the experiments an attempt was made to determine the effect of the apple bitter-rot fungus upon the pentose-containing compounds of the apple fruit, the relative value of certain pentoses and compounds of pentoses as sources of carbon for this fungus, and the effect of an aqueous extract of the fungus mycelium upon xylan. It was found that the fungus increased the alcohol-soluble pentosan content of the apple fruit, but decreased the total pentosan content. The fungus readily utilized either xylose, arabinose xylan or arabin as sources of carbon. The two pentoses were more favorable sources of carbon than glucose. Aqueous extracts of the fungus mycelium when allowed to act on xylan produced xylose. It is evident that the fungus secretes an enzyme, which hydrolyzes xylan to xylose.

Armillaria or Oak Fungus Disease in California: W. T. HORNE, University of California, Berkeley, Cal.

Cultures and specimens were exhibited and the action of the fungus briefly described.

There was considerable discussion of this important disease by a number of those present.

The sessions were presided over by Dr. Haven Metcalf in the absence of the president and vice-president of the American Phytopathological Society, and Professor R. E. Smith, president of the Pacific Division, and Professor H. S. Jackson, newly elected president of the Pacific Division, respectively. The attendance at these sessions varied from forty to fifty.

Wednesday, August 4, was spent with the botanists at Stanford University, and the plant pathologists joined the biologists in a dinner in San Francisco in the evening.

Following the reading of Dr. Shear's paper a motion was adopted directing the chairman to appoint a committee for the purpose of considering the question of the establishment of a culture supply laboratory. C. L. Shear, chairman, and L. R. Jones were appointed, with power to select a third member.

In the intermission between the second and third sessions, a business meeting of the Pacific Division was held, in which a report was made by the secretary-treasurer as to the activities of the society and its financial condition. Officers for the ensuing year were elected as follows: H. S. Jackson, president; J. T. Barrett, vice-president; W. T. Horne, secretary-treasurer. The question of affiliation with the Pacific Division of the American Association for the Advancement of Science was reported on and the matter of the next meeting was left until the next meeting of that society should be decided. The matter of relation to the parent society was then taken up and the report of the joint committee was adopted. The adoption of this report changes the name of the local society to the American Phytopathological Society, Pacific Division, and also reestablishes the distinction originally made between associate and active members, active members being those who are also members of the parent society.

C. L. Shear,
Secretary-Treasurer,
W. T. Horne,
Secretary-Treasurer,
Pacific Division.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, SECTION B, PHYSICS

The recent, August 2–7, California meetings of Section B of the American Association for the Advancement of Science were pleasant and profitable in every particular. The programs for three days, Tuesday, Wednesday and Thursday, had been amply provided for by a special committee of the Pacific Coast Division, of which Professor Fernando Sanford was chairman. These sessions, presided over by Vice-president Lewis were devoted to the presentation of rather full, invited papers and demonstrations on spectroscopy, high tension electric currents, and physics of the atmosphere. Friday's meetings, at which many brief papers were presented, were in charge of the American Physical Society, with President Merritt presiding.

All these meetings, however, were regarded as joint meetings between Section B and the Physical Society. Abstracts of the papers presented therefore will appear in the *Physical Review.*

Wednesday's meetings were held at the Stanford University, and given over entirely to a "Discussion and Demonstrations of High Potential Electric Currents" by Professor Harris J. Ryan. To say that these demonstrations, made in a building constructed especially for this purpose, were remarkable, is but to echo the statement of every one fortunate enough to see them.

But not all the meetings were for the presentation of scientific papers. Tuesday's luncheon given by Professors Lewis, Haskell and Leuschner at the Faculty Club, University of California, Wednesday's dinner at the Jules Café, San Francisco, and Saturday's excursion to the Lick Observatory were some of the most important meetings of the entire week, important because they contributed, as scarcely anything else could have contributed, to the perpetuation of old friendships and the beginning of new ones.

The vote of thanks, therefore, extended at the last session to the Pacific Coast Committee, to the University of California, to the Stanford University and especially to the physicists of the two institutions for making these meetings of Section B and the Physical Society so thoroughly successful was amply deserved and most heartily given.

W. J. Humphreys,
Secretary, Section B